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ENGINEERING DATA TRANSMITTAL

Page 1 of 2

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15. DATA TRANSMITTED

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1	WHC-SD-W049H-SE-004		0	Description of siting constraints, criteria and procedure, and identification of a preferred site for the 200 Areas Treated Effluent Disposal Basin	3	1		

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16. KEY

Impact Level (F)	Reason for Transmittal (G)	Disposition (H) & (I)
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1	1	Cog./Proj. Eng J. D. Davis			H4-55	D. E. Kelley		10/25/91	RT-48	1	1
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1	1	QA L. W. Vance	L. W. Vance	10/21/91	H4-16	~~R. G. Holt~~			~~A5-19~~	~~1~~	~~1~~
1	1	~~XXXX~~ Environmental Permits			H4-57	S. W. Seiler		10/24/91	B4-64	1	1
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7. Abstract This report recommends a preferred site to construct the Project W-049H facility for disposal of treated effluents from the Liquid Effluent Retention Facility on the 200 Areas Plateau of the U. S. Department of Energy's Hanford Site.

The constraints on areas that were considered for candidacy are identified. Then, the criteria for selecting the preferred site are identified and their rationale explained. Finally, the site-selection procedure is described and the preferred site is selected.

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- Site Evaluation Report -
Site Screening, Evaluation, and Selection

-- Project W-049H, 200 Areas Treated Effluent Disposal Basin --

Identification of the Preferred Site for Construction of the 200 Areas Treated Effluent Disposal Basin

Synopsis

This report recommends a preferred site to construct the Project W-049H facility for disposal of treated effluents from the Liquid Effluent Retention Facility on the 200 Areas Plateau of the U. S. Department of Energy's Hanford Site.

First, the constraints on areas that were considered for candidacy are identified. Then, the criteria for selecting the preferred site are described and their rationale explained. Finally, the site-selection procedure is described and the preferred site is selected.

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1.0 INTRODUCTION

This report describes how potential sites were evaluated and a preferred site selected for construction of an infiltration basin to dispose of treated effluent (hereafter referred to as the 200 Areas TEDB) for Project W-049H, near the Liquid Effluent Retention Facility (LERF) (Figure 1). The background, objectives, scope, and regulations considered in preparing this site evaluation are discussed first, followed by discussions of the constraints on candidacy, screening and selection criteria, and the process used to apply the criteria. Finally, the screening and selection criteria are applied, the relative merits of candidate sites are evaluated, and a preferred site for construction of the 200 Areas TEDB is identified for detailed characterization and evaluation of environmental acceptability.

1.1 Background

Past waste disposal practices at Hanford included discharge of untreated liquid effluents directly to ponds and trenches that infiltrated the effluents into thick, unconsolidated sediments overlying basalt bedrock. This practice was accepted at that time because of characteristics of the area such as isolation from major population centers, low precipitation, a deep water table, and ion-exchange properties of the sediments underlying the site. However, in March 1987 the U. S. Department of Energy's (DOE) Richland, Washington Field Office (DOE-RL) published a report that stated the DOE would end the discharge of untreated liquid effluents (DOE 1987).

The Hanford Federal Facility Agreement and Consent Order (Tri-Party Agreement) (Ecology, EPA and DOE 1989; as amended in 1990) established a schedule and milestones to either treat these effluents prior to their discharge or eliminate the discharge. Siting, construction, and operation of the 200 Areas TEDB are required to comply with the following milestones of the Tri-Party Agreement:

- Milestone M-17-00 -- Complete Liquid Effluent Treatment Facilities and/or Upgrades for All Phase I Streams by June 1995
- Milestone M-17-08 -- Complete 200 Areas Treated Effluent System by June 1995
- Milestone M-26-03 -- Cease Discharge to the LERF by December 1994

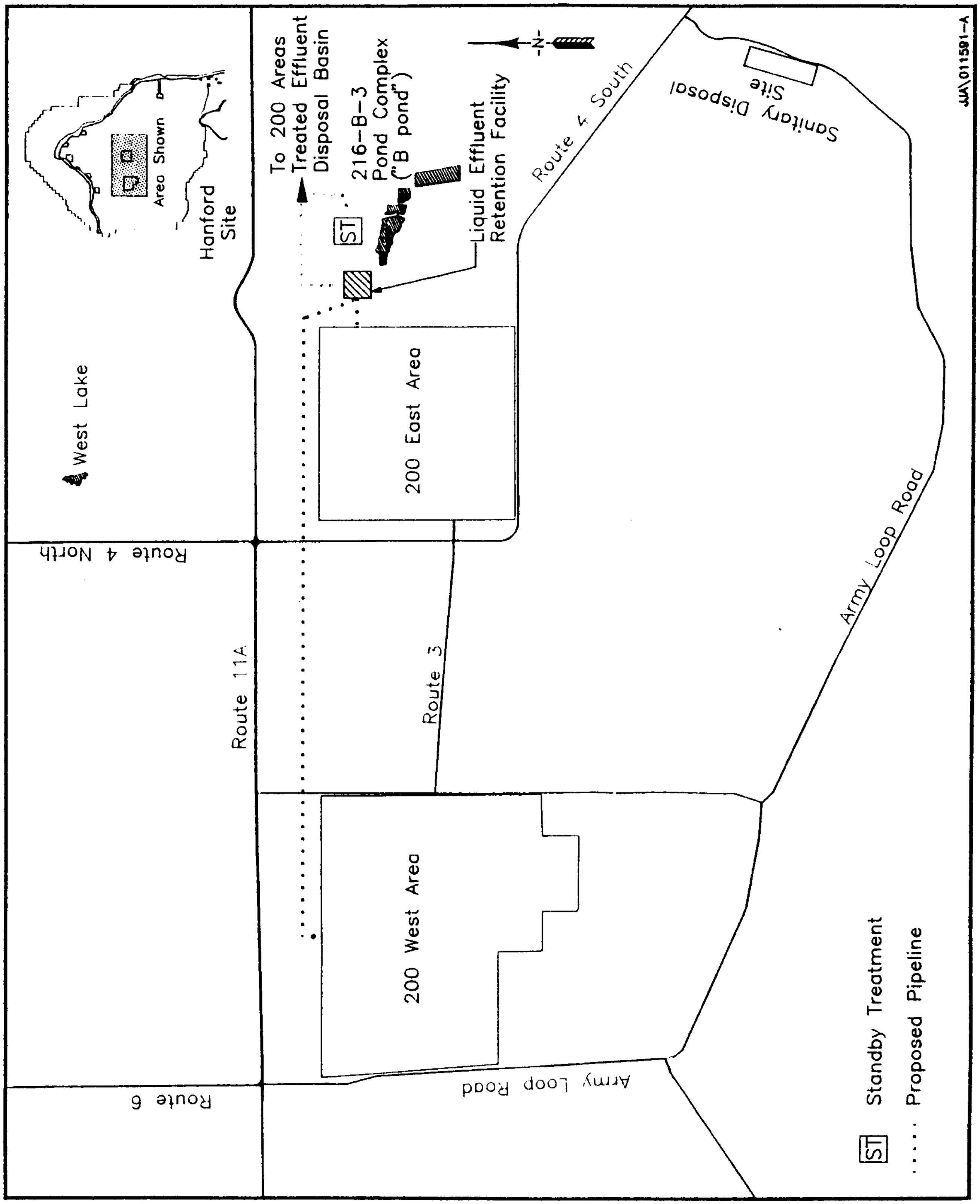

Figure 1. Location of the Liquid Effluent Retention Facility.

- Milestone M-26-04 -- Remove Hazardous Waste Residues from the LERF by June 1995.

In addition, the site evaluation process is to comply with the method approved by DOE and Ecology for assessing the effects of liquid discharge on ground water at disposal sites (Milestone M-17-13).

Westinghouse Hanford Company (WHC) has identified a temporary effluent-storage site (Trost 1990) immediately east of the 200 East Area (see Figure 1); construction of the LERF at this site has begun. The LERF will consist of three basins, each with two impermeable liners and capable of containing up to approximately 6.5 million gallons, or a total of 19.5 million gallons. Once the Project C-018H Treatment Facility is in operation, the basins will be emptied. The effluent from the emptied basins will be treated as required and discharged to a state-approved (Project C-018H and/or W-049H) location within the Hanford Site (Figure 2).

The effluents discharged to the LERF basins will be sampled, analyzed, and verified as complying with WAC 173-216 discharge acceptance criteria before being released for discharge to the 200 Areas TEDB. The acceptance criteria may include the most restrictive of Primary, Secondary, and proposed Maximum Contaminant Levels identified in the Federal Safe Drinking Water Act (SDWA) and Water Quality Standards for Groundwater, as stated in WAC 173-200. Practical Quantification Limits (lowest value, 40 CFR Part 264, Appendix IX) may be used as the concentration limits for substances not identified in the SDWA or in WAC 173-200. No dangerous waste as per WAC 173-303 will be discharged.

1.2 Objective

The objectives of this report are to (1) identify and explain the criteria and the process that were used to identify and evaluate the relative merits of the candidate sites for construction of the 200 Areas TEDB and (2) document the choice of a site preferred for further, detailed characterization to verify its environmental acceptability for effluent disposal.

1.3 Scope

This Site Evaluation Report (SER) uses the criteria and the process previously identified and described by the technical program plan (TPP) for the 200 Areas TEDB (Davis 1991). The SER is required by DOE Order RL 4320.2C to ensure that facilities at Hanford comply with functional design requirements while considering human health, environmental protection, cost, and land-use planning factors. The scope of this SER is limited to (1) identifying the criteria that were used to pick candidate sites and determine the preferred site for the 200 Areas TEDB, (2) providing the rationale for using those

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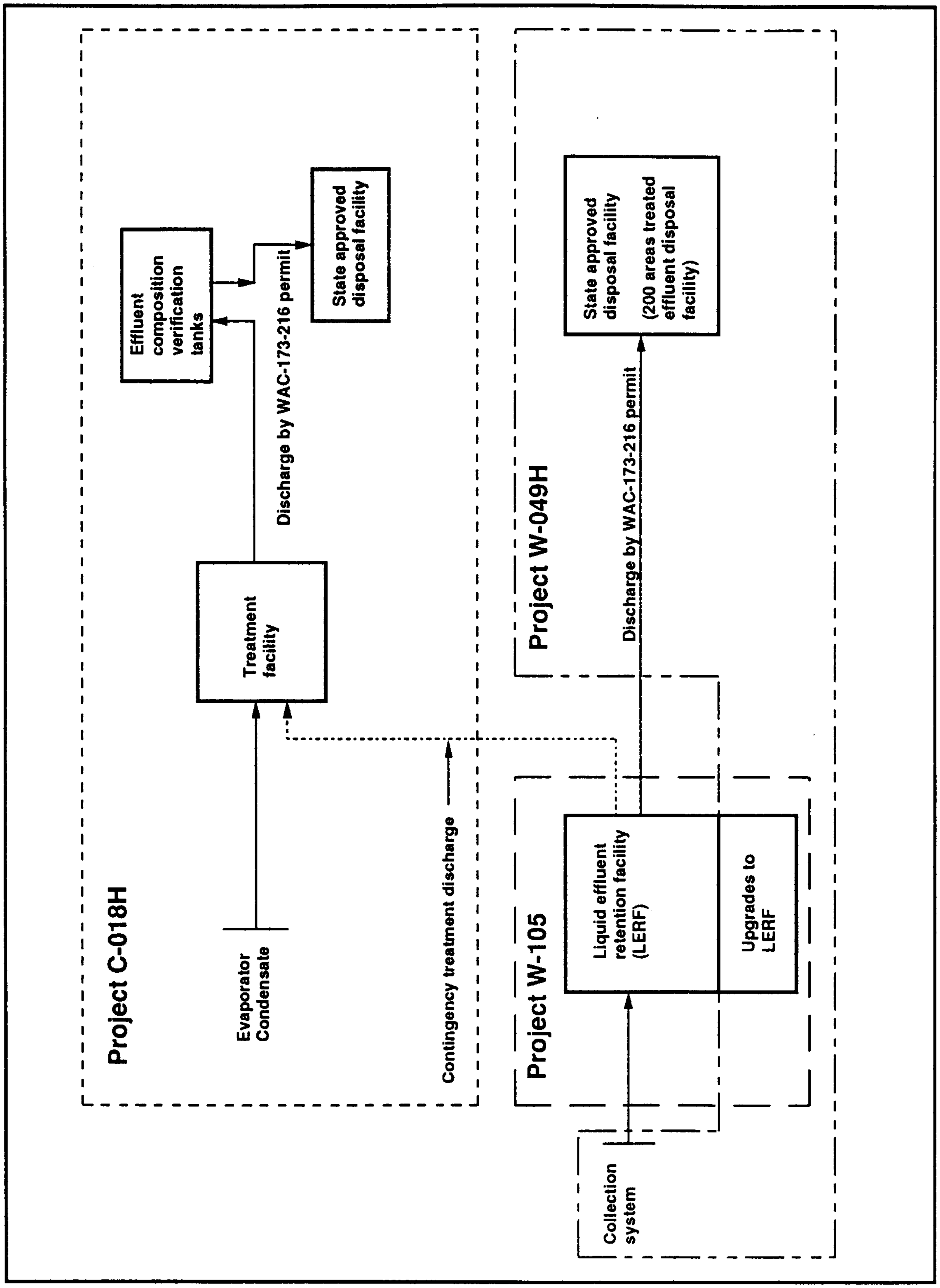

Figure 2. Interrelationships of Projects C-018H, W-105, and W-049H.

criteria, (3) describing the process for applying them, and (4) identifying a preferred site.

Concurrent with issuance of this SER, plans for work to confirm the site's environmental acceptability are being prepared for review and comment. The site characterization work plan (SCWP) will identify the site characterization work, explain why it is needed, describe the methods that will be used to collect and analyze data, and offer a schedule and estimated cost of completion. The relationship of this SER to the TPP and the SCWP is summarized in Figure 3. The information resulting from detailed characterization of the site will subsequently be issued in a site characterization report (SCR) (see Fig. 3) that provides the information required by WAC 173-216 and WAC 173-240 and is consistent with DOE- and Ecology-approved methods for assessing environmental impacts.

1.4 Regulatory Considerations

The intent of this SER is to ensure compliance with the applicable regulatory requirements of WAC 173-216 in identifying an environmentally acceptable site for the 200 Areas TEDB and confirming its suitability. Approval from Ecology will be sought for the 200 Areas TEDB through the Washington State Waste Discharge Permit Program. The purpose of permits issued under the auspices of the administrative code is to comply with Section 307 of the Federal Water Pollution Control Act (33 U.S.C., §1251).

2.0 FUNCTIONAL DESIGN CONSIDERATIONS

Several considerations based on functional design requirements for Project W-049H (Kerr, Rev. 0 1990) helped constrain the areas from which candidate sites for the 200 Areas TEDB were identified. These considerations were as follow:

- 30-year design life
- Capacity to accommodate disposal of 1,500 gpm
- Slopes of retention berms that either allow escape of humans or animals, or are fenced to prohibit entry
- An inspection and maintenance road around the infiltration basin
- Underground effluent supply piping protected from freezing.

The first two of these functional design considerations required a land area sufficiently large to accommodate infiltration of effluent for the planned rate and duration. The remaining considerations required that the effluent disposal facility be located in terrain suitable for minimizing disturbance to the environment, occupational hazards, and

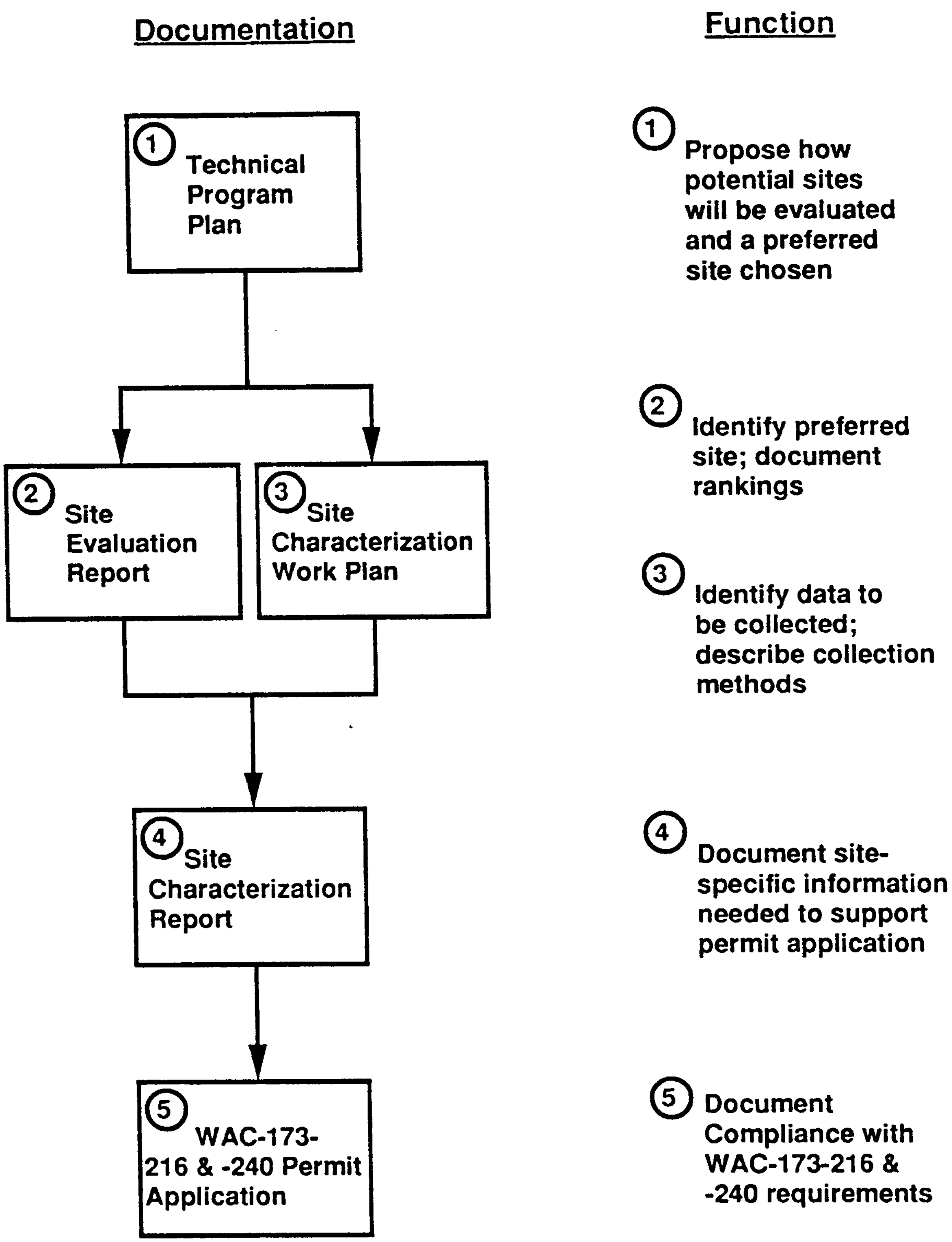

Figure 3. Relationships of the Technical Program Plan to the Site Evaluation Report, Site Characterization Work Plan, and Site Characterization Report.

the risk of spills, leaks or failure of the containment structures.

2.1 Risk Factors

Proximity to the effluent source was a major consideration in siting the 200 Areas TEDB. A location remote from the LERF would require more excavation for effluent supply-pipeline construction; hence, could increase the risk of disturbing contaminated areas and would likely increase the risk of pipeline rupture, leaks, or spills during operation. Evaluation of currently available geologic, hydrologic, land-use, and contaminant location information (Appendix A) suggested that environmentally acceptable candidate sites were likely present in the vicinity of the LERF. Consequently an arbitrary maximum distance of 2 miles from the LERF was chosen to focus the evaluation on nearby areas to reduce risks likely to be associated with more distant candidate sites. Only if detailed characterization of the highest-ranked site in the vicinity of the LERF were to indicate that site is environmentally unacceptable would the necessity of selecting a more distant site be reevaluated. Figure 4 shows the area available for consideration within 2 miles of the LERF.

The local topography of the land surface is of principal regard in eliminating from further consideration those areas that are not suitable sites for the 200 Areas TEDB. Locations with elevations lower than that of the LERF would permit gravity flow from the LERF. Areas with relatively steep slopes and high local relief would require significantly more cut-and-fill for berm construction and could pose appreciably greater risk of containment structure failure than those with more gentle slopes and low relief.

For these reasons, gently sloping surfaces with relatively low topographic relief were preferred and a constraint of ≤ 2% maximum slope of the land surface was used to screen unsuitable areas from further consideration. For the general area of interest within 2 miles of the LERF (see Fig. 4), a more gentle maximum-slope criterion was judged to be needlessly constraining; steeper slopes were judged to pose unnecessary risks. Figure 5 shows areas available for consideration within 2 miles of the LERF that slope ≤ 2%.

2.2 Effluent Capacity and Infiltration Rates

The current functional design criteria for the 200 Areas TEDB and related Project facilities (Kerr, Rev. 0 1990) specify an average effluent discharge of 1,500 gallons of effluent per minute (gpm) (2,160,000 gallons per day (gpd)). However, the disposal basin may eventually need to accommodate additional fluxes of effluent, depending on which waste streams are treated and whether they are eventually routed to the basin.

Rates of infiltration of liquid effluent at the Hanford Site have been found to be highly dependent on both the hydrologic characteristics of the location and the chemistry of the effluent. Nevertheless, based on Hanford Site experience, higher equilibrium rates of infiltration can generally be expected for paired-basin facilities designed to operate in

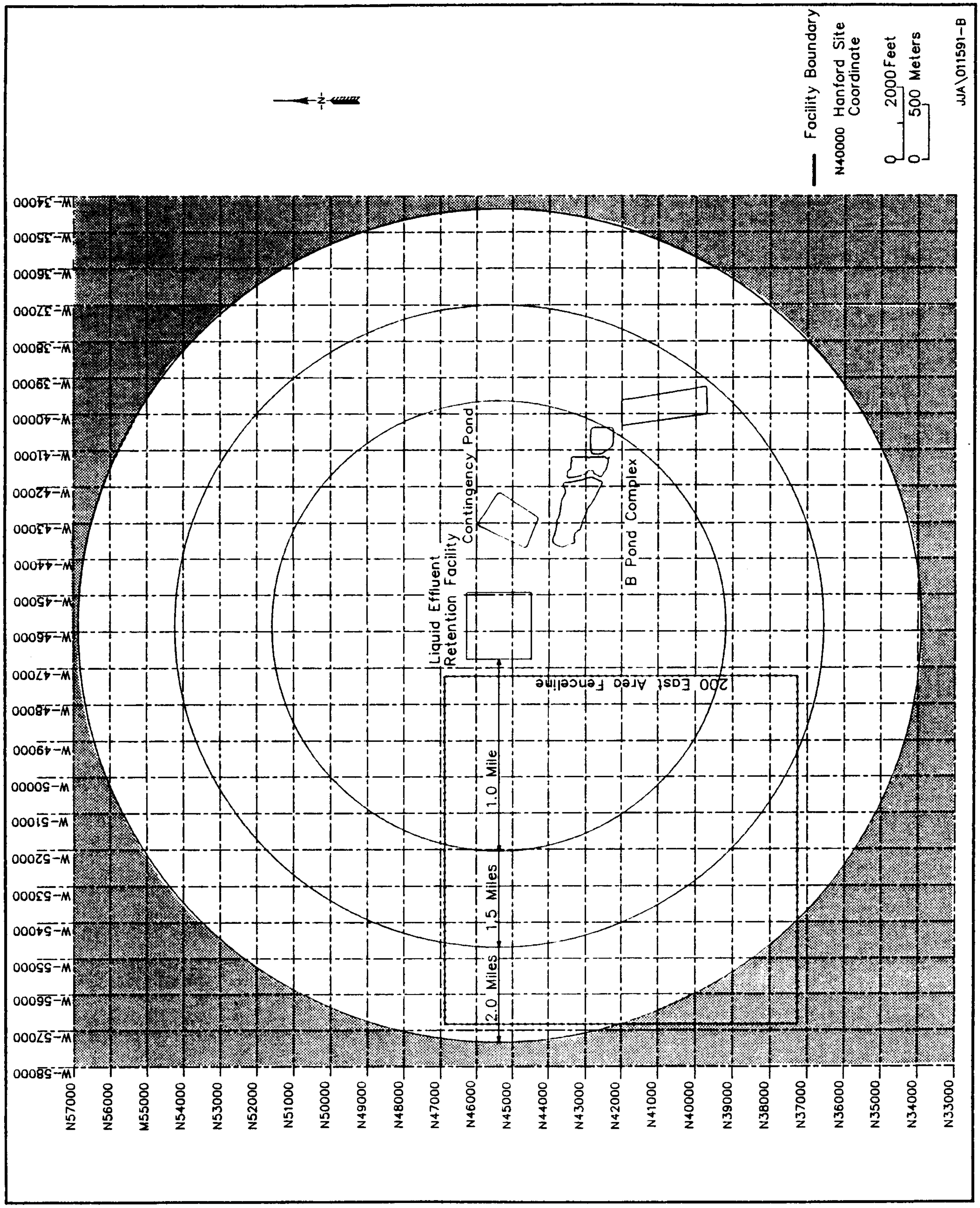

Figure 4. Area Within a 2-Mile Radius of the Liquid Effluent Retention Facility (Unshaded).

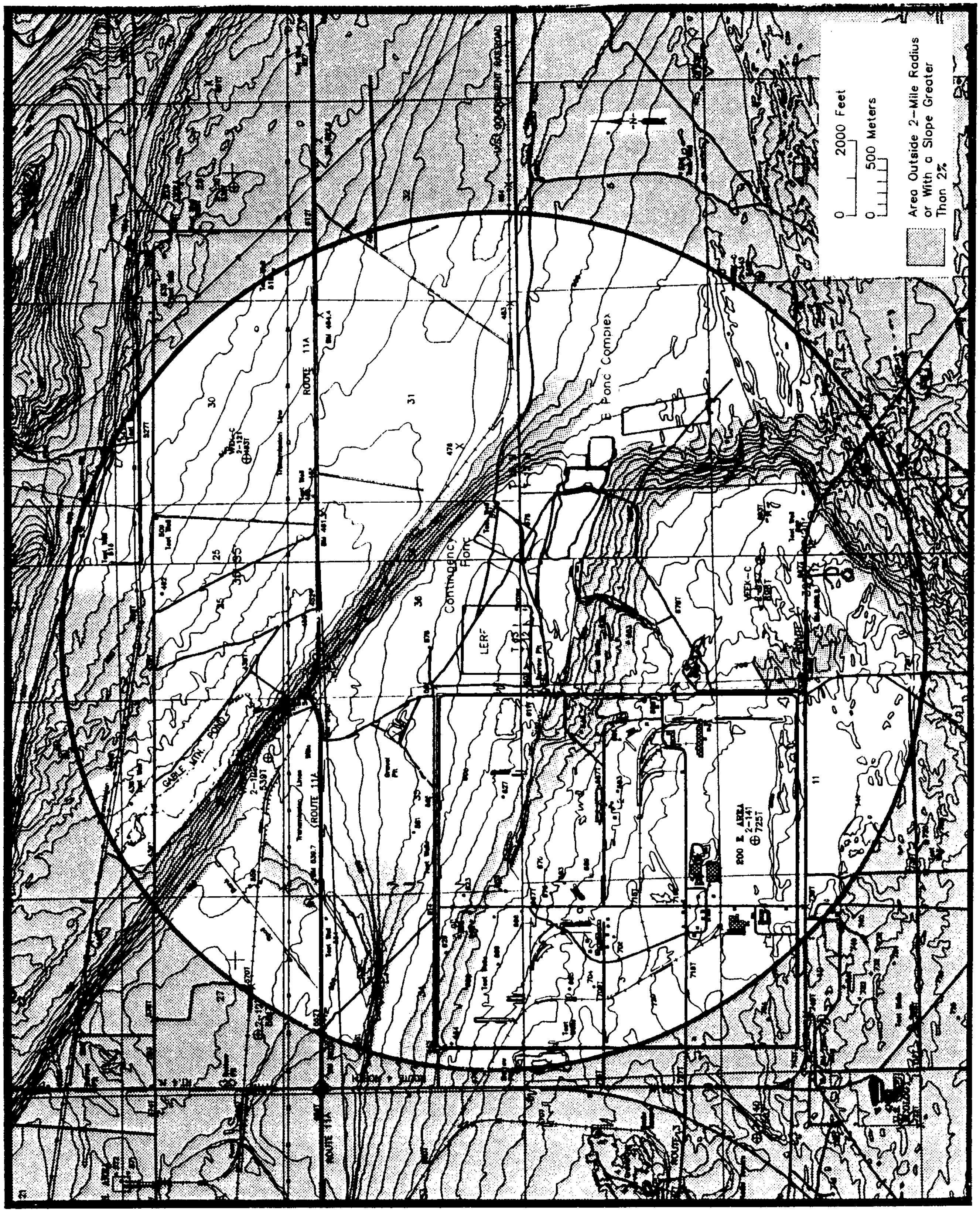

Figure 5. Area of Interest in Figure 4 With a Slope of 2% or Less (Unshaded).

alternating cycles. The alternate wetting and drying cycles inhibit the growth of algae and permit periodic removal of fine-grained siltation or precipitation products that, within a relatively short time, can appreciably reduce the infiltration rate due to clogging of the pore space in the bottom of the pond. For such paired ponds, experience indicates that infiltration rates on the order of 20 gallons per day per square foot (gdf^2) may in some locations be expected. For designs that do not permit cyclic operation, experience with effluent disposal cribs (Chapman-Riggsbee 1985) and the 216-B-3 Pond system (subsequently termed "B Pond") suggests that an infiltration rate of 10 gdf^2 is generally appropriate for facility sizing.

To stipulate how much land would be needed for the 200 Areas TEDB, either an infiltration rate of 20 gdf^2 can be assumed for a paired-basin design, or a rate of 10 gdf^2 can be assumed for a larger, single-basin facility that is not designed for cyclic operation; both designs require about the same amount of land. Assuming a rate of effluent discharge of 1,500 gpm and an infiltration rate of 20 gdf^2, the minimum area of land needed would be 108,000 ft^2 (2.48 acres). Consequently, a minimum of approximately 5 acres would be needed for a 200 Areas TEDB that could be operated either with or without alternate wetting and drying cycles.

Areas within 2 miles of the LERF with slopes of $\leq$ 2%, but that are smaller than 5 equidimensional acres, were not considered to be viable candidate sites for the facility. Figure 6 shows the availability, within 2 miles of the LERF and with slopes of $\leq$ 2%, of areas $\geq$ 5 acres that would permit construction of an infiltration basin with reasonably regular boundaries.

3.0 CANDIDATE SELECTION CRITERIA

Screening criteria (Westinghouse 1990, 1991) derived from DOE guidelines (DOE-RL Order 4320.2C, *Site Selection* (1990) and DOE Order 6430.1A, *General Design Criteria*, Section 200-1 (1989)) were used to determine whether the areas constrained by the functional design considerations discussed in Section 2 were suitable candidate sites for the 200 Areas TEDB. These screening criteria are:

(1) Conflict with Current Land Use
(2) Negative Effect on RCRA, CERCLA or Effluent Disposal Sites
(3) Negative Effect on Cultural Resources
(4) Negative Effect on Threatened or Endangered Species.

These criteria provided the means for deciding whether areas that are within 2 miles of the LERF, have a slope of $\leq$ 2%, and contain a minimum of 5 acres within a reasonably regular boundary were worthy of further consideration. Areas that passed these screening criteria were subsequently ranked for relative merit; those that failed the

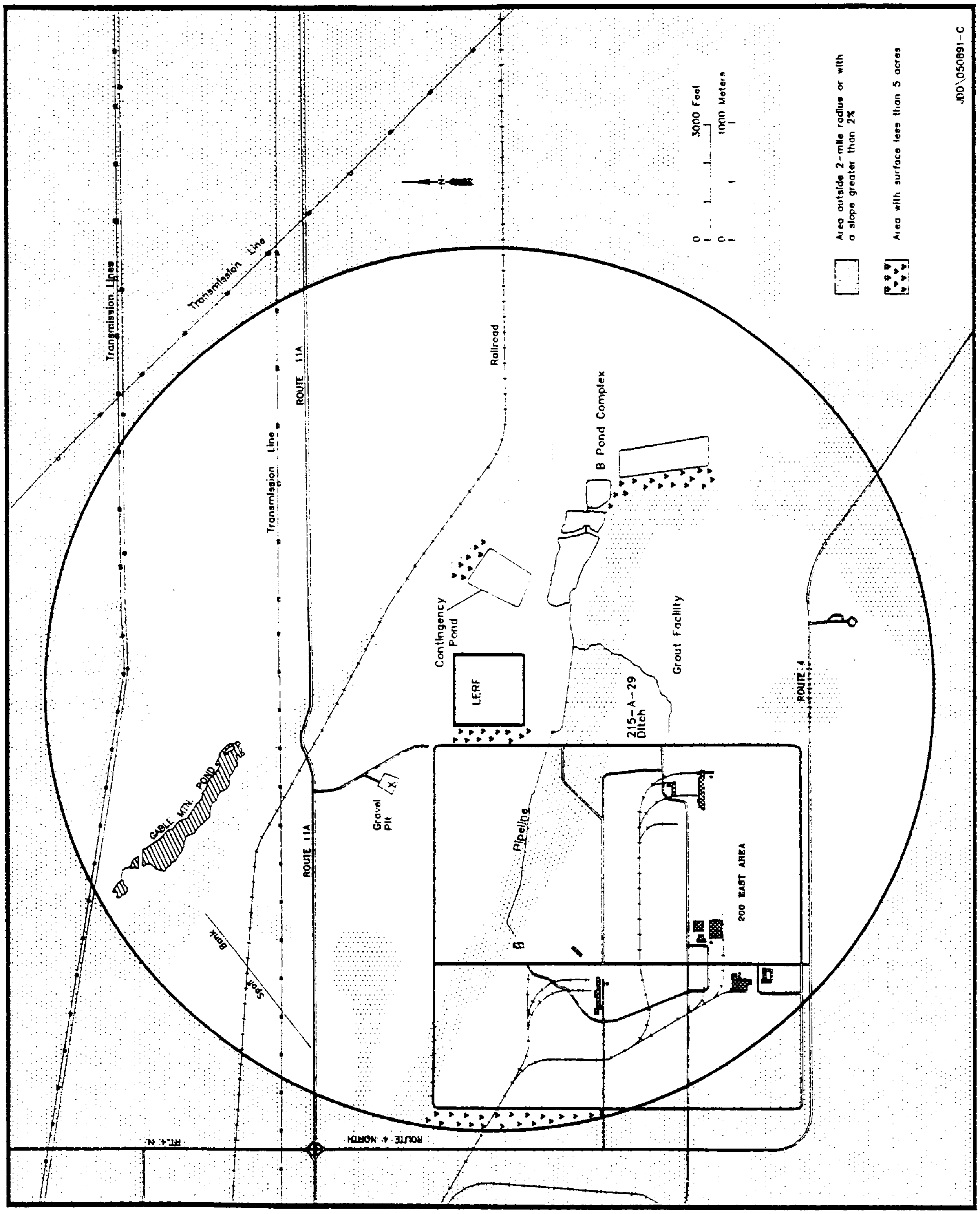

Figure 6. Area of Interest in Figure 5 With a Minimum Surface Area of 5 Acres Within a Reasonably Regular Boundary (Unshaded, Unpatterned).

criteria were dropped from further consideration.

3.1 Conflict with Current Land Use

This criterion was needed to ensure that use of a potential site for the 200 Areas TEDB would not conflict with any current use of that site. A conflict that could not be resolved satisfactorily disqualified a location from further consideration. Figure 7 shows the areas within 2 miles of the LERF, with slopes of ≤ 2% and a minimum of 5 acres within reasonably regular boundaries, that have no conflict with other current or planned uses.

3.2 Negative Effect on RCRA, CERCLA or Effluent Disposal Sites

This criterion was used to ensure that areas believed to have subsurface contamination, and sites that are currently being considered for disposal of other treated effluents under the provisions of a WAC 173-216 permit would not adversely be affected by operation of the 200 Areas TEDB. Areas believed to have subsurface contamination (Figure 8) were not considered to be viable candidates for siting the 200 Areas TEDB because of the potential for contaminant remobilization. (See Appendix A, *Hydrogeologic Evaluations*, for maps of subsurface contaminants in the area of interest; Figure 8 is a composite of these appended maps of specific contaminants).

3.3 Negative Effect on Cultural Resources

This criterion was used to ensure that cultural, historic, or archeologic resources are preserved. Information needed to apply this criterion was provided from analysis of field surveys previously conducted and analyzed in accordance with the Hanford Cultural Resources Management Plan (Chatters 1989). (See Appendix B, *Cultural Resources Review*). Figure 9 shows areas within the general area of interest that had previously been surveyed for archeologic resources and the dates of their survey. A detailed survey of the cultural resources of the preferred site was made in August 1991. No candidate areas were determined to be known to contain cultural resources.

3.4 Negative Effect on Threatened or Endangered Species

This criterion was used to ensure the preservation of threatened or endangered plants or animals. These evaluations were made by Hanford Site personnel qualified to conduct the requisite field surveys and analyze the resulting information. None of the candidate areas were determined to contain populations of threatened or endangered species. (See Appendix C, *Survey for Threatened or Endangered Species.*)

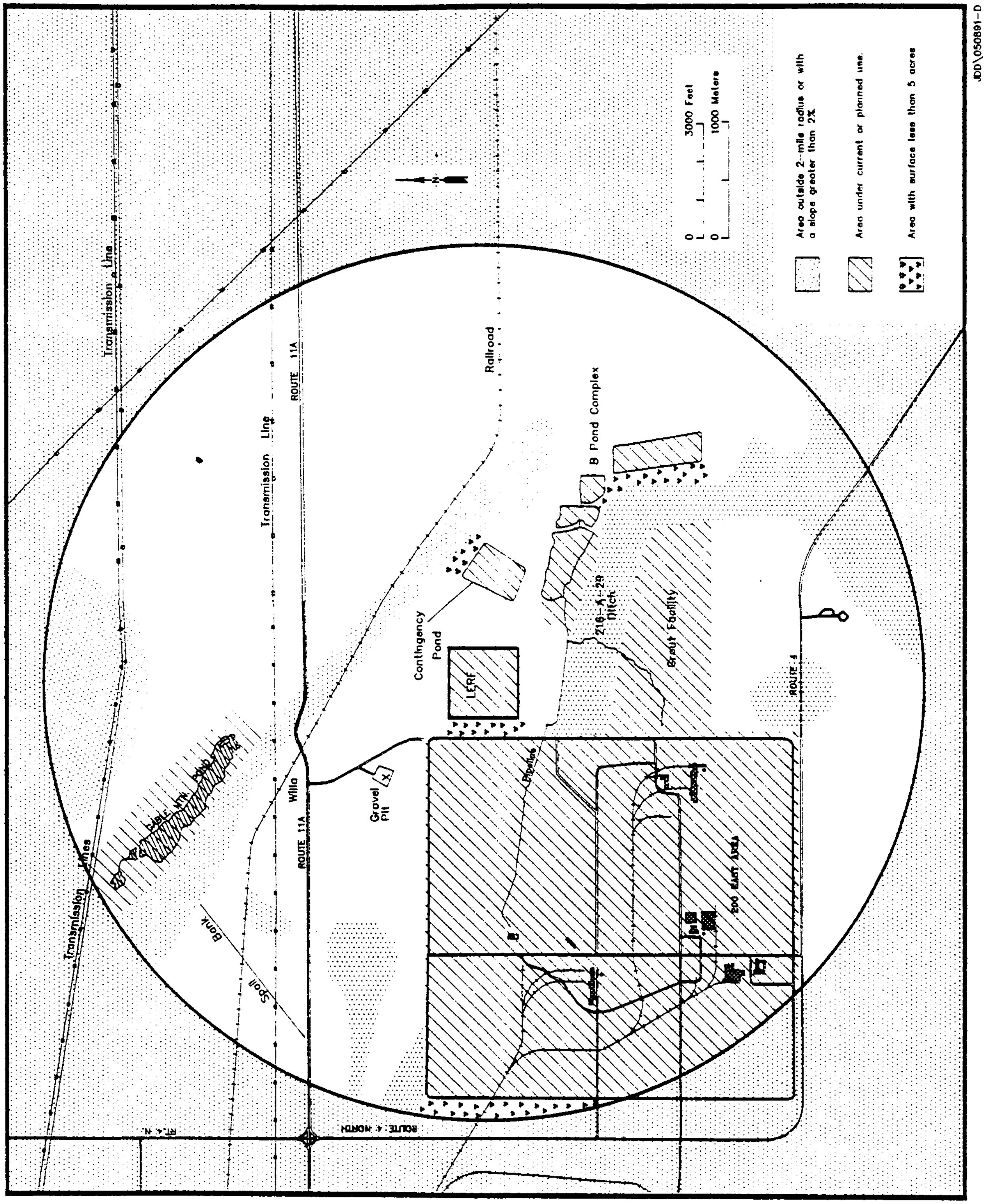

Figure 7. Area of Interest in Figure 6 Having No Known Conflicts With Other Current or Planned Uses (Unshaded, Unpatterned).

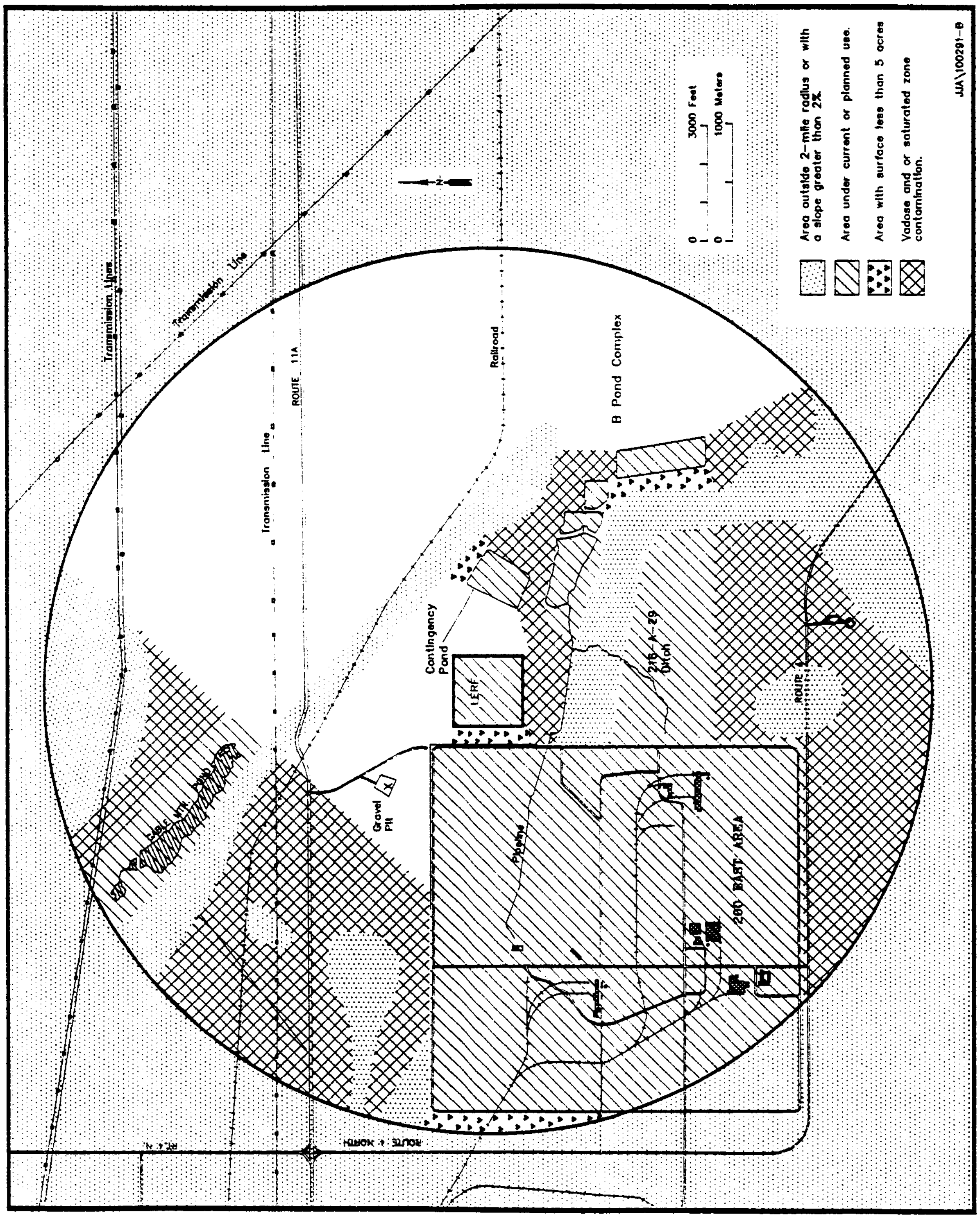

Figure 8. Area of Interest in Figure 7 With No Known Contaminants or Adverse Effects on Other Treated Effluent Disposal (Unshaded, Unpatterned).

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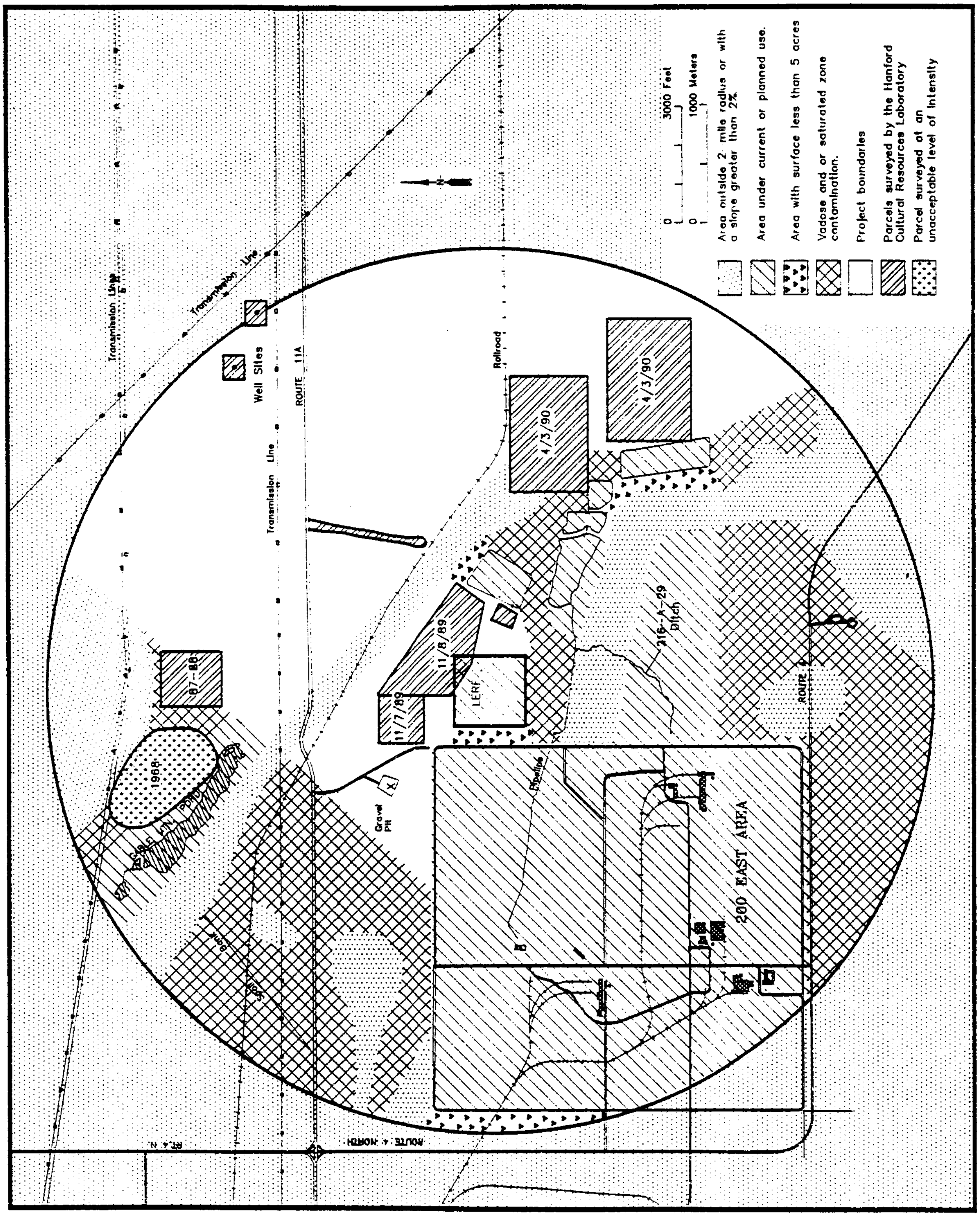

Figure 9. Areas Previously Surveyed for Cultural Resources in the Area of Interest. (Date of survey is shown for each surveyed area).

4.0 CANDIDATE RANKING CRITERIA

These criteria provided the means to evaluate the relative merits of areas that complied with all of the functional design considerations (see Section 2) and all of the screening criteria (see Section 3). Each ranking criterion was assigned a numerical weighting that reflected its relative importance. Determination of relative importance of the ranking criteria and assignment of weighting are discussed in Section 5.

Because of the potential effects of construction and operation of the 200 Areas TEDB on worker safety and the unconfined aquifer, two types of criteria were judged as needed to evaluate the relative merits of candidate areas:

(1) Safety and environmental protection --

- (a) Human Health and Safety During Construction and Operation
- (b) Potential for Enhancing or Impeding the Migration of Contaminants, and

(2) Design, construction, and operation --

- (a) Obstructions between the 200 Areas TEDB Candidate Site and the LERF
- (b) Interference with the Operation of Other Facilities
- (c) Availability of Adjacent Land for Expansion.

4.1 Safety and Environmental Protection Considerations

These ranking criteria were considered to be of overriding importance; they were used to evaluate the differences between candidate areas that related to occupational health and safety of construction and operating personnel, to health and safety of the public, and to protection of the environment.

4.1.1 Human Health and Safety During Construction and Operation

This criterion was used to weigh the relative merits of candidate areas with respect to the health and safety of construction and operation personnel. The criterion was applied by using a philosophy of reducing the exposure of workers to radiation and hazardous substances and conditions to as low as reasonably achievable (ALARA) (Westinghouse 1989).

For example, a candidate area judged likely to have less risk to workers engaged in excavating and laying of the effluent supply pipeline because it had the least potential for intersecting an area of contamination would be ranked higher than a candidate site with a longer effluent supply line or one that would cross an area with known or suspected contamination.

Similarly, potential risk to operating personnel that would result from areas of known or suspected contamination in proximity to the facility or its access, if it were constructed at the location being considered, was evaluated by means of professional judgment relative to other candidate sites.

4.1.2 Potential for Enhancing or Impeding the Migration of Contaminants

Application of screening criterion 3.2, *Negative Effect on RCRA, CERCLA, or Effluent Disposal Sites*, ensured that areas with known or suspected subsurface contamination or a high potential to adversely affect other discharges of treated effluent were removed from consideration as sites for the 200 Areas TEDB. Hence, the purpose of this criterion was to ensure that relative potential for either positive or negative effects on the migration of known or suspected contamination in the vicinity of the candidate areas was accounted for in assessing the merits of alternative candidate sites.

Adverse effects on the migration of known or suspected contamination were defined as follow:

- TEDB effluent is likely to cause significant reduction of the projected travel time or increase in the flux of contaminants to the Columbia River or other publicly accessible source of drinking water, or

- The operation of an existing RCRA site would be hindered or the remediation of an existing RCRA or CERCLA site would be made more difficult or less effective.

This criterion was applied to ensure that candidate areas which are relatively distant or down-gradient from known or suspected contamination are ranked higher than those that are closer to, or up-gradient from, contaminated areas. This criterion was also used to enhance the rankings of candidate areas at which a rise in the water table down-gradient of known contamination would likely reduce or reverse the existing gradient between the contamination and the Columbia River, causing an increase in the contaminant travel time and/or lengthening of the contaminant migration path to the river -- both of which would be beneficial effects.

The potential for these effects was evaluated by computer simulations of the consequence of infiltrating 1,500 to 15,000 gpm of effluent in each candidate area, with or without operation of the B Pond system (see Appendix A). These consequences were reflected by changes in the elevation of the water table, hydraulic head gradients, flow paths, and contaminant travel times during the life of the 200 Areas TEDB and subsequent reversion to the pre-existing gradient of the unconfined aquifer.

Conceptual models based on current geologic and hydrologic knowledge of the candidate areas were used to numerically simulate the effects of the infiltration of Project W-049H effluent discharges. Geologic cross sections, and data-location, structure-contour, isopach and water-table maps that formed the basis for the conceptual models are in Appendix A. Maps of known surface, unsaturated zone and unconfined aquifer contamination are also shown in Appendix A.

Three-dimensional, finite-difference software, "MODFLOW", (U. S. Geological Survey, McDonald and Harbaugh 1988) was used for the simulations (see Appendix A). If analysis of the information provided by the simulations suggested that effluent disposal at a candidate area had the potential to remobilize surface or unsaturated zone contaminants known to be present in the vicinity, then that candidate was ranked lower. Similarly, if the analysis suggested a potential to significantly shorten the travel time or increase the flux of contaminants known to be present nearby in the unconfined aquifer, then that area was ranked lower. Additional, more sophisticated simulations of the hydrology of the preferred site will be made when site characterization data become available. These more detailed assessments of the site-specific effects of effluent discharge will be made in a manner consistent with DOE- and Ecology-approved methods.

4.2 Design, Construction, and Operational Considerations

These ranking criteria were subordinate to human health and safety criteria and were used to evaluate candidate-area differences relating to design, construction, and operation of the 200 Areas TEDB.

4.2.1 Obstructions between the 200 Areas Treated Effluent Disposal Basin and the Liquid Effluent Retention Facility.

This criterion was applied to rank the number and magnitude of features between the LERF and the candidate areas that could obstruct construction of the 200 Areas TEDB. These obstructions could be (1) effluent and power supply lines, (2) access roads and rail lines, and (3) areas of surface or subsurface contamination requiring remedial actions. Locations that offered the fewest potential obstructions were preferred.

4.2.2 Interference with the Operation of Other Facilities.

This criterion was used to evaluate the potential for interference with current operations in the vicinity of the candidate areas or between the LERF and the candidate areas during operation of the 200 Areas TEDB. For example, during operation of the

TEDB nearby operations could be affected by the local rise in the water table. Similarly, construction or operation of other Hanford Site facilities in the 200 Areas could interrupt operation of the TEDB. Candidate areas with the least potential for interference were preferred.

4.2.3 Availability of Adjacent Land for Expansion.

As indicated in Section 2.2, the capacity of the 200 Areas TEDB may need to be increased. Based on current discharges to various effluent disposal facilities in the 200 Areas and projected disposal needs, an area sufficiently large to infiltrate approximately 15,000 gpm (21,600,000 gpd) of effluent may eventually be needed. An area adjacent to the candidate site that is sufficiently large to accommodate expansion of the facility is desirable because of the site characterization, and pipeline or other construction costs required to service another facility at one or more widely separated locations.

Assuming either an infiltration rate of 20 gdf^2 for paired basins or 10 gdf^2 for a single-basin design, the surface area needed to accommodate 15,000 gpm of effluent discharge would be about 3,160,000 ft^2, or nearly 50 acres (also see Trost 1990); hence, candidate areas that have at least 50 acres of adjacent land available for facility expansion were preferred.

5.0 SITE SELECTION

As previously noted in Section 4.0, the five ranking criteria were judged not to be of equal importance -- human health and environmental protection were the overriding concerns. Consequently, different numerical weights were assigned to each criterion based on professional judgment. Selection of a preferred site for construction of the 200 Areas TEDB was based on determination of which candidate scored highest, overall.

5.1 Weighting of Ranking Criteria

Human health and environmental protection were considered to be essential in selecting a site suitable for the 200 Areas TEDB. Hence, the criteria described in Section 4.1 were assigned 60% of the total candidate-site evaluation score. The design, construction and operational considerations described in Section 4.2 were assigned the remaining 40% (Figure 10).

Because protection of ground water beneath the Hanford Site and in the Columbia River is essential to human health and safety, Criterion 4.1.2, *Potential for Enhancing or Impeding the Migration of Contaminants*, was assigned a weight of 70% of the criteria of Section 4.1. The remaining 30% was assigned to Criterion 4.1.1, *Human Health and Safety During Construction and Operation.*

	Safety and Environmental Protection Criteria (60%)					Design and Constructibility Criteria (40%)								Score Totals	
	Potential Effect on Ground Water and Existing Contamination (70%)			Potential Effect on Occupational Health and Safety (30%)		Availability of Adjacent Land for Expansion (50%)		Obstructions Between LERF and 200 Areas TEDB (25%)			Interference with Operations of Other Facilities (25%)			Raw	Weighted & Normalized to 100 %
	Negative	Neutral	Positive	Elevated Risk	Minor Risk	No	Yes	Substantial	Some	None	Substantial	Some	None		
	Ranking Score														
Candidate Site	0	40	70	15	30	0	50	0	10	25	0	10	25		
A															
B															
C															
D															

Figure 10. Summary of Weighting and Scoring for Candidate Ranking Criteria.

Operation of the 200 Areas TEDB is central to plans to comply with environmental regulations for waste disposal and remediation in the 200 Areas. Because of the potentially large volume of the 200 Areas effluent streams as discussed in Section 4.2.3, the availability of adjacent land for expansion was judged to merit relatively heavy weighting. Consequently, Criterion 4.2.3, *Availability of Adjacent Land for Expansion*, was assigned a weight of 50% of the criteria of Section 4.2. Of the remaining 50%, half each was assigned to Criterion 4.2.1, *Obstructions between 200 Areas Treated Effluent Disposal Basin and the Liquid Effluent Retention Facility*, and Criterion 4.2.2, *Interference with the Operation of Other Facilities.*

5.2 Selection Procedure

Candidate sites within the areas described in Sections 2 and 3 were screened and ranked by individuals with demonstrable expertise and experience in pertinent fields:

- Land use planning
- Regulatory permits
- Ground water hydrology
- Geological engineering and/or civil engineering
- Environmental science, wildlife biology, zoology, and/or botany
- Archaeology
- Occupational health and safety, and
- Design and Construction.

Participants were asked to (1) judge the suitability of an area as a candidate site and (2) rank the candidate sites by means of the criteria and weighting system. Participants were instructed to apply only those criteria that pertained to their fields of expertise. The raw and weighted scores were computed for each criterion of relative merit. The scores were summed and the candidate sites were ranked accordingly.

The area available for ranking of candidate sites (see Figure 8) was arbitrarily subdivided into the four candidate areas, A, B, C, and D, shown in Figure 11. The objective of the subdivision was to provide several choices from which to select a preferred candidate site. A 50-acre reference candidate site (see Figure 11) was located within each candidate area based on its proximity to (a) borehole hydrogeologic data, (b) the LERF, and (c) relative lack of interference with roads, rail lines and other Hanford Site

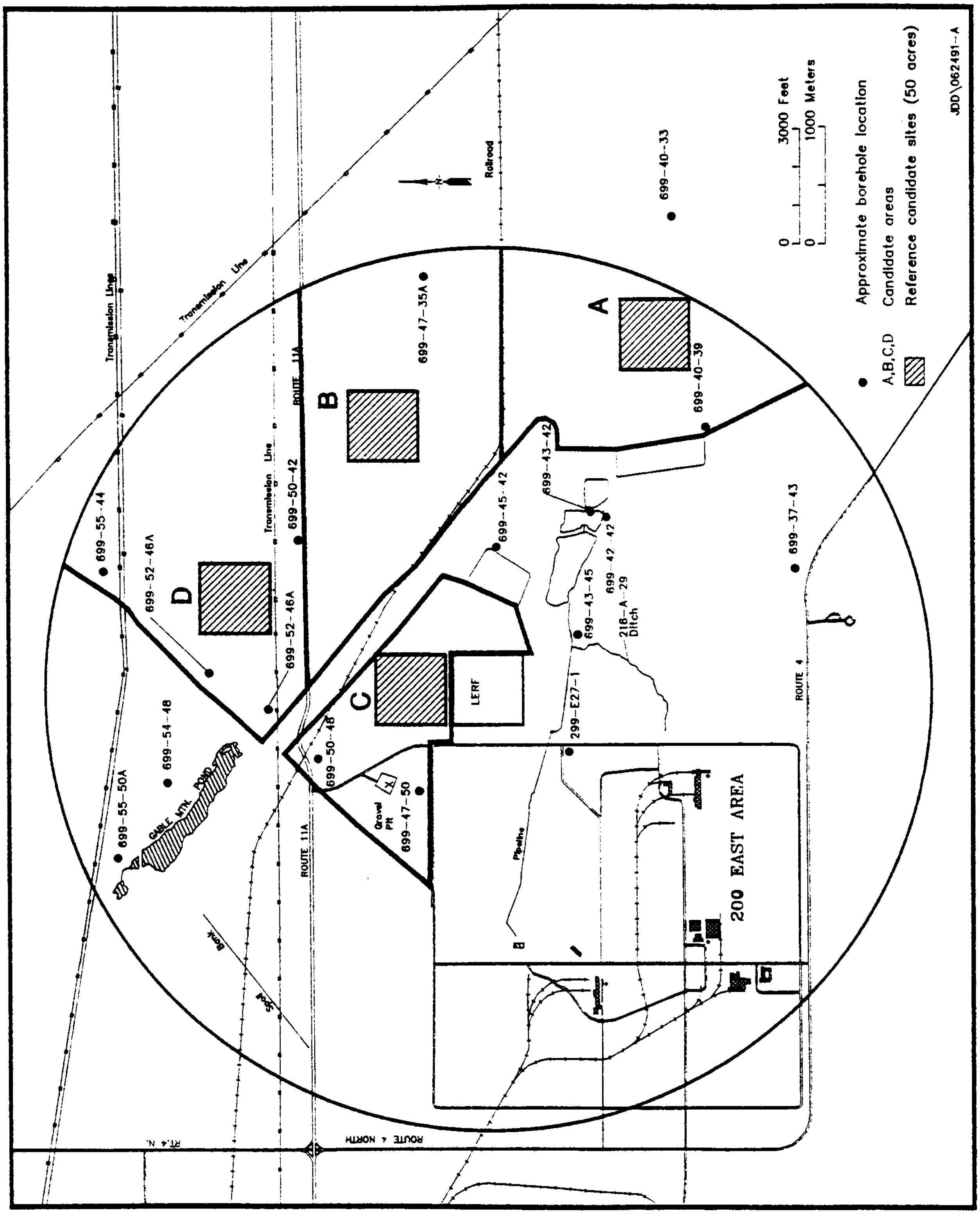

Figure 11. Locations of Candidate Areas, Reference Candidate Sites, and Data Used in Computer Simulations.

facilities.

5.3 Selection of the Preferred Site

Figure 12 summarizes the scores achieved by the four candidate sites using the five ranking criteria. The figure shows the raw scores for the four candidate sites, for each of the five ranking criteria. Raw and weighted scores are given in the two columns at the right side of the figure. The weighted scores are normalized to 100. Reference candidate site "A" is clearly the preferred site for construction of the 200 Areas TEDB (Figure 13) for the reasons that follow.

Candidate site "A" ranks higher than the other four sites for its potential effect on ground water flow and existing contamination. This ranking is based on its potential to provide a hydraulic barrier or impediment by locally reducing or reversing the hydraulic gradient between upgradient tritium contamination of the unconfined aquifer from the B Pond complex and the Columbia River (Appendix A). In contrast, operation of the TEDB at candidate site "C" would likely increase the hydraulic gradient upgradient of the tritium contamination, thereby providing a mechanism for decreasing the time required for the contamination to reach the Columbia River. Candidate site "B" is sufficiently far removed from areas of known contamination that it would likely neither positively nor negatively affect movement of known contamination. Contamination underlying Gable Mountain Pond could be either positively or negatively affected by treated effluent from candidate site "D". Operation of the TEDB at site "D" could provide a hydraulic barrier to easterly movement of contaminants. However, large influent flows could drive the contaminants to the northwest, through the gap between Gable Mountain and Gable Butte and, hence, north to the Columbia River.

Candidate site "A" is ranked somewhat lower than candidate sites "B" and "D" and is ranked the same as candidate site "C" for Occupational Health and Safety. The lower ranking of "A" and "C" results from the necessity to construct an effluent supply pipeline for candidate site "A" through an area that may contain slight subsurface contamination (see Figure 8) and the local presence of "speck" contamination (see Appendix A, Figure A.2.2) on the surface at candidate site "C". Sites "B" and "D", and the subsurface through which the effluent supply pipeline to them would be constructed, are believed to be contaminant free.

All four candidate sites are ranked equally in terms of the availability of adjacent land for expansion. However, site "C" would have the most constraints on the direction and dimensions of land available should expansion be needed.

Sites "A" and "C" are ranked equally and higher than sites "B" and "D" with respect to the type and number of obstructions between the LERF and the candidate site. No obstructions to construction of the effluent supply pipeline are envisioned for sites "A" and

9 2 1 2 3 6 3 1 5 0 5

	Safety and Environmental Protection Criteria (60%)					Design and Constructibility Criteria (40%)								Score Totals	
	Potential Effect on Groundwater and Existing Contamination (70%)			Potential Effect on Occupational Health and Safety (30%)		Availability of Adjacent Land for Expansion (50%)		Obstructions Between LERF and 200 Areas TEDB (25%)			Interference with Operations of Other Facilities (25%)			Raw	Weighted & Normalized to 100 %
	Negative	Neutral	Positive	Elevated Risk	Minor Risk	No	Yes	Substantial	Some	None	Substantial	Some	None		
	Ranking Score														
Candidate Site	0	40	70	15	30	0	50	0	10	25	0	10	25		
A			X	X			X			X			X	185	91
B		X			X		X		X				X	155	76
C	X			X			X			X		X		100	43
D		X			X		X	X					X	145	72

Figure 12. Rankings of Candidate Sites.

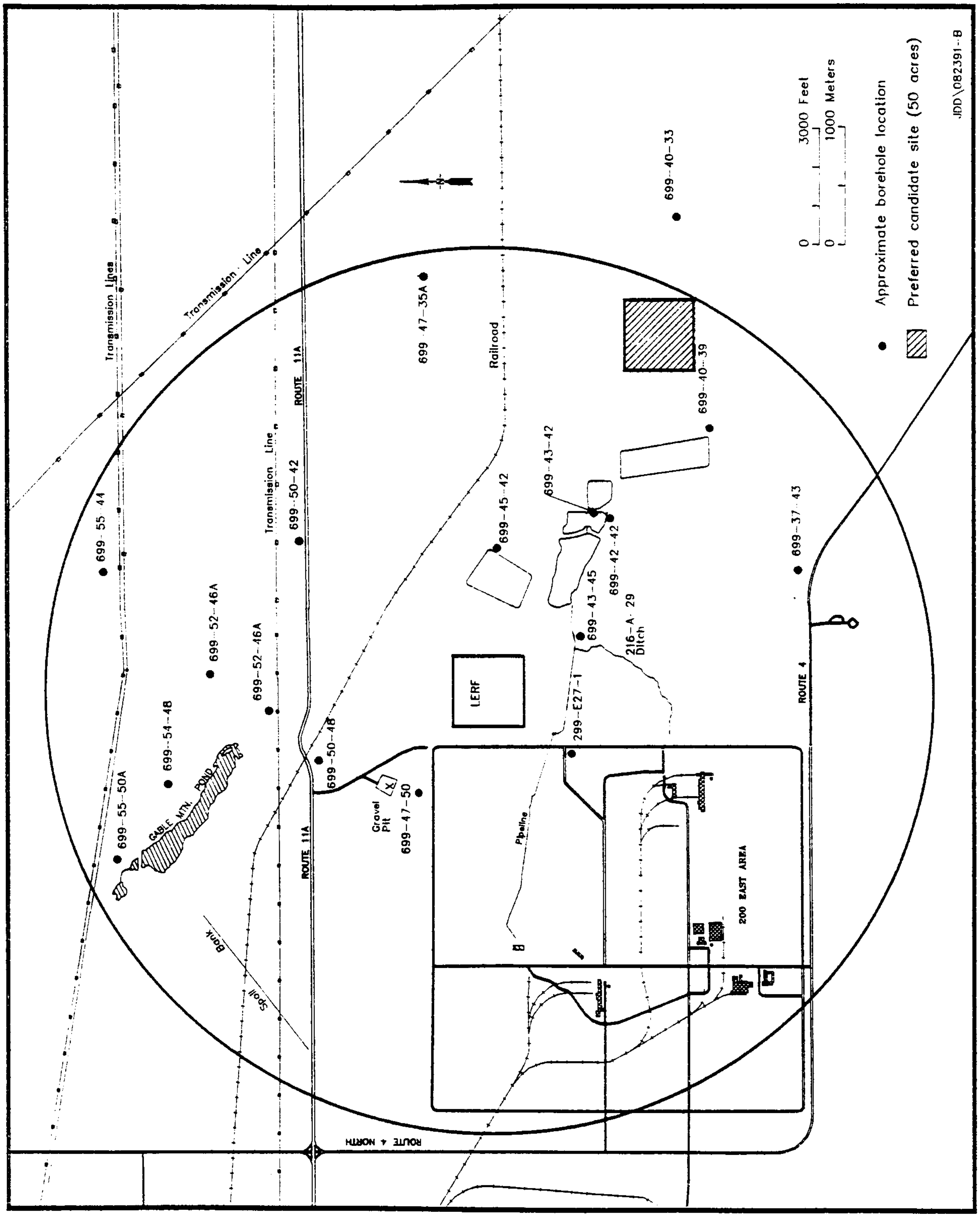

Figure 13. Location of the Preferred Site for Construction of the 200 Areas Treated Effluent Disposal Basin.

"C". Candidate site "A" may be able to utilize all or part of the effluent pipeline currently supplying the C Lobe of the B Pond complex. The effluent supply line for candidate site "B" would have to cross a railroad. Candidate site "D" is ranked lowest because the effluent supply line would have to cross a railroad, a four-lane divided highway, and the right-of-way for electric power transmission lines.

Candidate sites "A", "B", and "D" are ranked equally for the criterion that judges their potential for interference with the operation of other Hanford Site facilities. No interference is anticipated if the TEDB were to be constructed at these sites. In contrast, site "C" is downgraded for this criterion because of potential interference with the deep trench excavated for burial of naval submarine reactor compartments in the northeast corner of the 200 East Area.

In summary, candidate site "A" is judged to be the best site for construction and operation of the 200 Areas treated effluent disposal basin. Detailed characterization and assessment of the environmental effects of the basin in accordance with DOE- and Ecology-approved methods will be required to confirm the site's environmental acceptability. Concurrent with completion and issuance of this SER, plans for work to confirm the site's environmental acceptability are being prepared for review and comment. The site characterization work plan (SCWP) will identify the site characterization work, explain why it is needed, describe the methods that will be used to collect and analyze data, and offer a schedule and estimated cost of completion.

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APPENDIX A

HYDROGEOLOGIC EVALUATIONS

The information of this appendix is organized into three parts:

(1) Hydrogeologic data
  (a) Data locations
  (b) Geologic cross sections
  (c) Structure contour maps
  (d) Isopach maps

(2) Locations of contamination
  (a) General areas of surface and subsurface contamination
  (b) Contamination of the unconfined aquifer

(3) Computer simulations of the projected hydrologic effects of the TEDB at each candidate site
  (a) Description of MODFLOW software
  (b) Description of analysis
  (c) Results for each reference candidate site
  (d) Analysis of results.

The hydrogeologic and contaminant location data were used to identify data deficiencies and to formulate conceptual models of the hydrogeology beneath each candidate area. These conceptual models, in turn, formed the basis for the simulations of ground water movement and contaminant transport used to help evaluate the relative merits of the four candidate sites.

A.1 HYDROGEOLOGIC DATA

-- K. A. Lindsey --

A.1.a Data Locations

Figure A.1.1 shows the locations of boreholes that supplied data to construct the geologic cross sections, structure contour maps, and isopach (thickness) maps that follow. Candidate areas "C" and "D" have the most data. Relatively few data are available from candidate areas "A" and "B".

A.1.b Geologic Cross Sections

The surface projections of the lines of four cross sections through candidate areas "A", "B", "C" and "D" are shown in Figure A.1.2. The section lines were located and

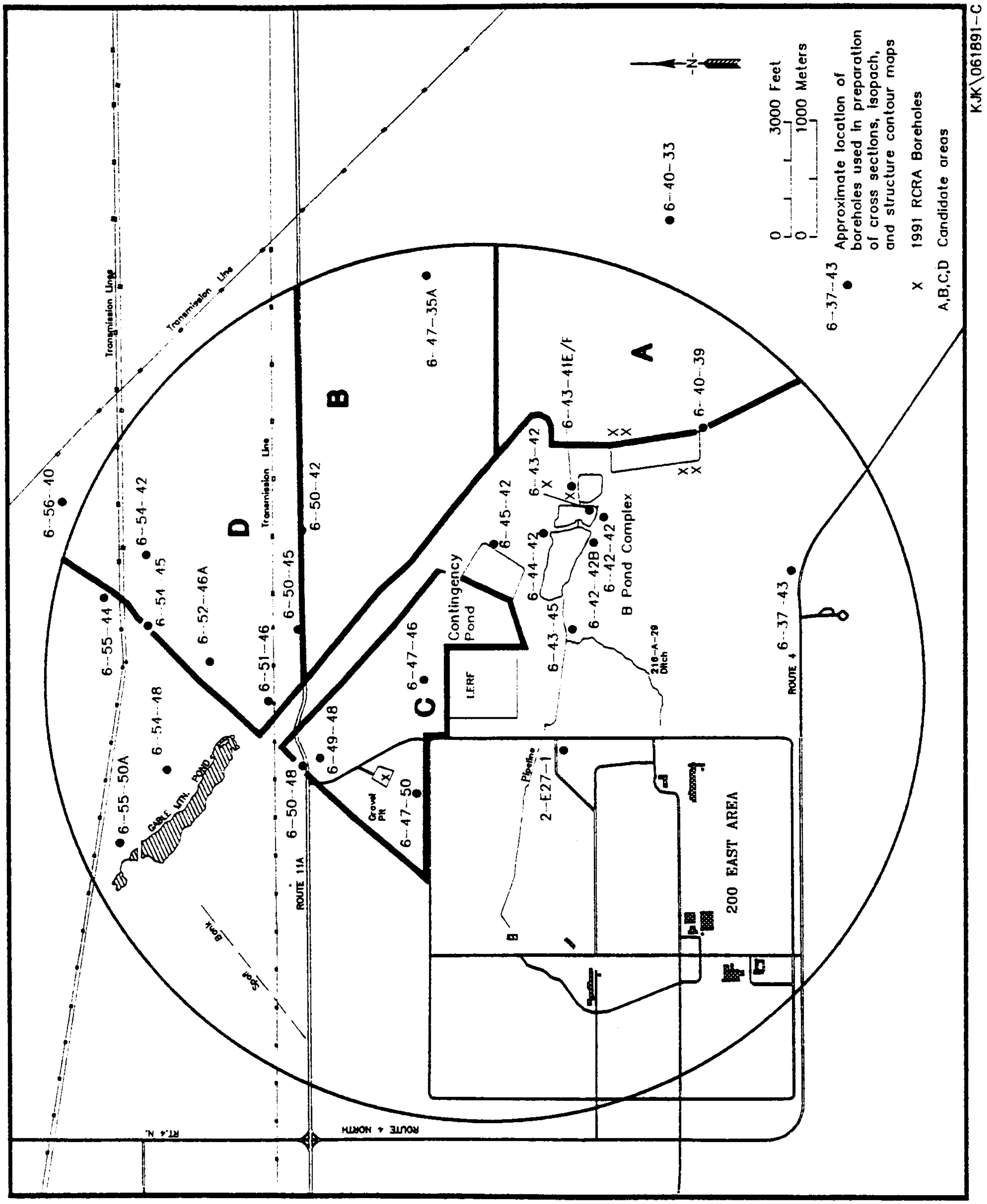

Figure A.1.1 Locations of Borehole Data Used to Construct Geologic Maps.

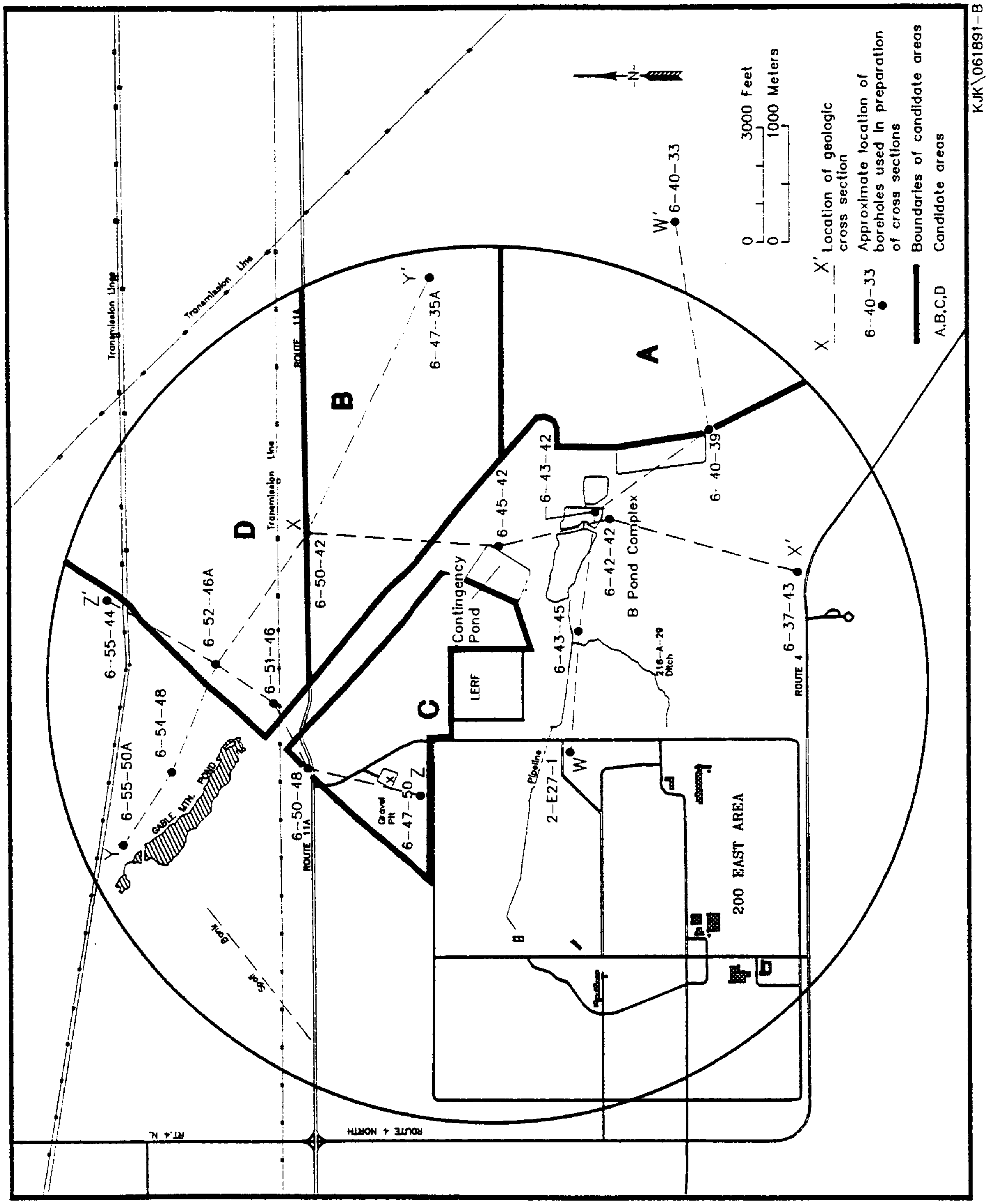

Figure A.1.2 Locations of Geologic Cross Sections.

oriented to maximize the hydrogeologic information available from the scattering of existing boreholes. An explanation of the geologic conventions and symbols used on the cross sections is provided by Figure A.1.3. Figures A.1.4 through A.1.7 are the cross sections whose locations are shown on Figure A.1.2.

A.1.c Structure Contour Maps

Figure A.1.8 shows the areas in which basalt bedrock is above the water table in the areas of interest. In these areas, water infiltrating from the surface generally migrates laterally, down the surface of the impermeable basalt, until it encounters the water table. However, a small area in the northeast corner of the 200 East Area where a window has been eroded through the Elephant Mountain Basalt, the uppermost confined aquifer may be directly accessible to downward migrating treated effluent.

The surface of the basalt beneath the candidate areas is shown in Figure A.1.9. Beneath candidate area "A", the basalt is 150 to 350 ft above sea level and dips south-southeast. Beneath candidate area "B", the basalt is shallower, generally from 350 to 400 ft above sea level, dipping gently north-northwest. Beneath most of candidate areas "C" and "D", the basalt is nearly flat-lying at about 400' above sea level.

A.1.d Isopach Maps

Within the candidate areas, the thickness of Ringold Formation overlying the basalt varies from 0 to approximately 225 ft (Figure A.1.10). The thickest section of Ringold Formation in the areas of interest is beneath candidate area "A", thickening from about 100 ft in the north to approximately 225 ft in the south. Beneath candidate area "B", Ringold Formation appears to thin from about 75 ft in the south to 0 in the northwest corner. Except for the extreme southeast corner, Ringold Formation is likely absent beneath candidate area "C". Virtually no information on the Ringold Formation is available for candidate area "D", but it appears to be thin to absent in the west and 25 to 50-ft thick in the southeast.

The variation in thickness of the Hanford formation overlying Ringold Formation in the areas of interest is shown in Figure A.1.11. Beneath candidate area "A", the Hanford formation thickens from about 60-80 ft in the north to 120-140 ft in the south. Beneath candidate area "B", the Hanford formation thickens from about 40 ft in the northeast to 80-100 ft in the southwest. In candidate area "C", the Hanford formation varies from about 180-ft thick in the south to approximately 100 ft in the north. The Hanford formation is thickest (100 ft) in the west-northwest part of candidate area "D" and thins to the north, south, and east. Along the north edge of this candidate area, it is about 80-ft thick; in the southwest, 20 to 40-ft thick; to the east, it is is likely on the order of 60-ft thick.

Legend

Lithologic Information

S P
c/z C/B - Grain Size Scale, Showing Sizes of Dominant Particles

c/z - Clay and Silt

S - Sand

P - Pebble Gravel

C/B - Cobble-Boulder Gravel

Lithographic symbols used to supplement grain size scale

- Cobbly to Bouldery

- Pebbly

- Sandy

- Silty to Clayey

- Pedogenic Carbonate

- Paleosol

- Basalt

X - No Data

Other Symbols

UR - Upper Unit of Ringold Formation

FSE, FSC, & FSA - Gravel-Dominated Intervals in Ringold Formation (See Lindsey 1991 & Delaney et. al. 1991)

Water Table

Formation Contacts

Lithofacies Contacts

H9106024.5

Figure A.1.3 Explanation of Map Symbols on Geologic Cross Sections.

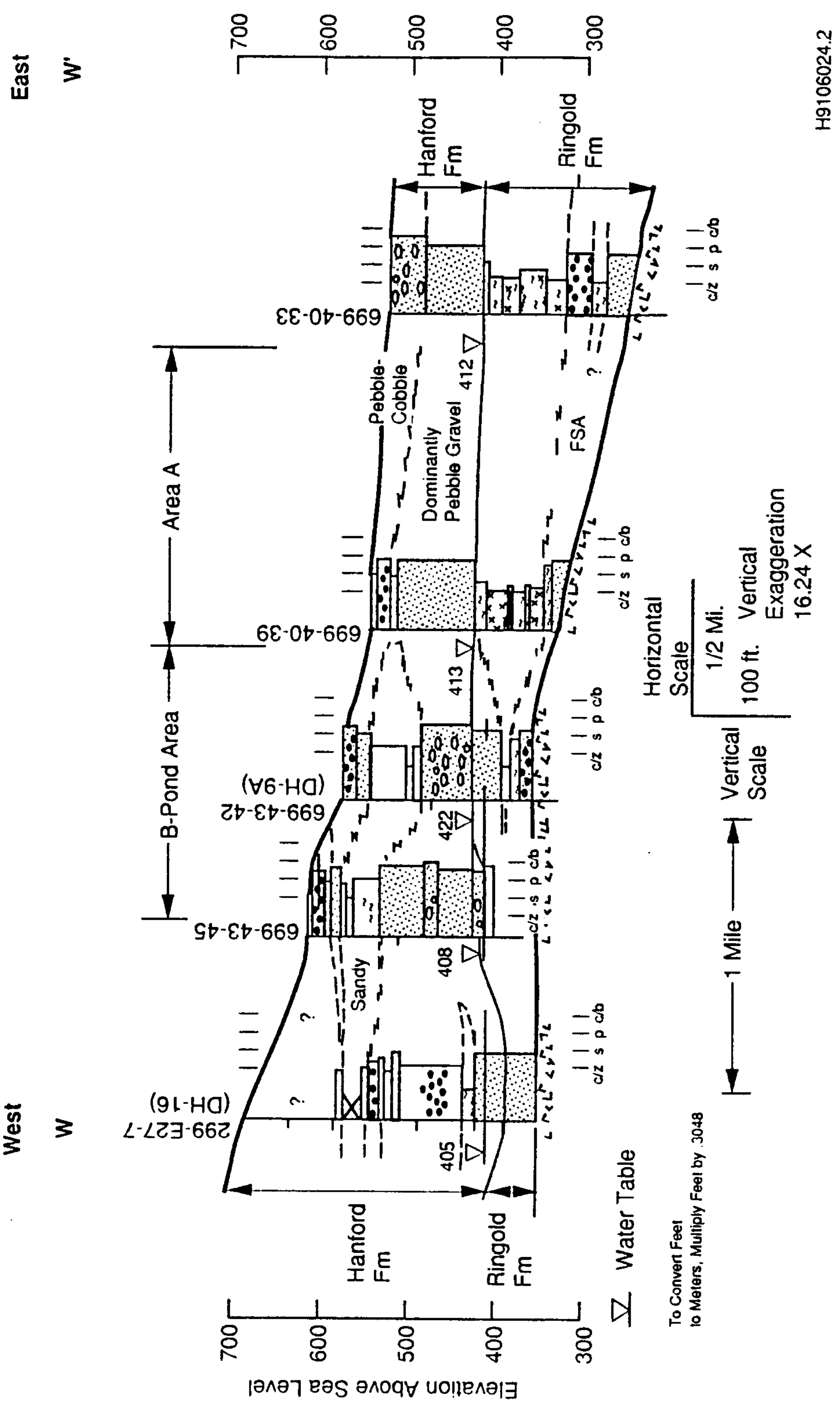

Figure A.1.4 Geologic Cross Section W-W'.

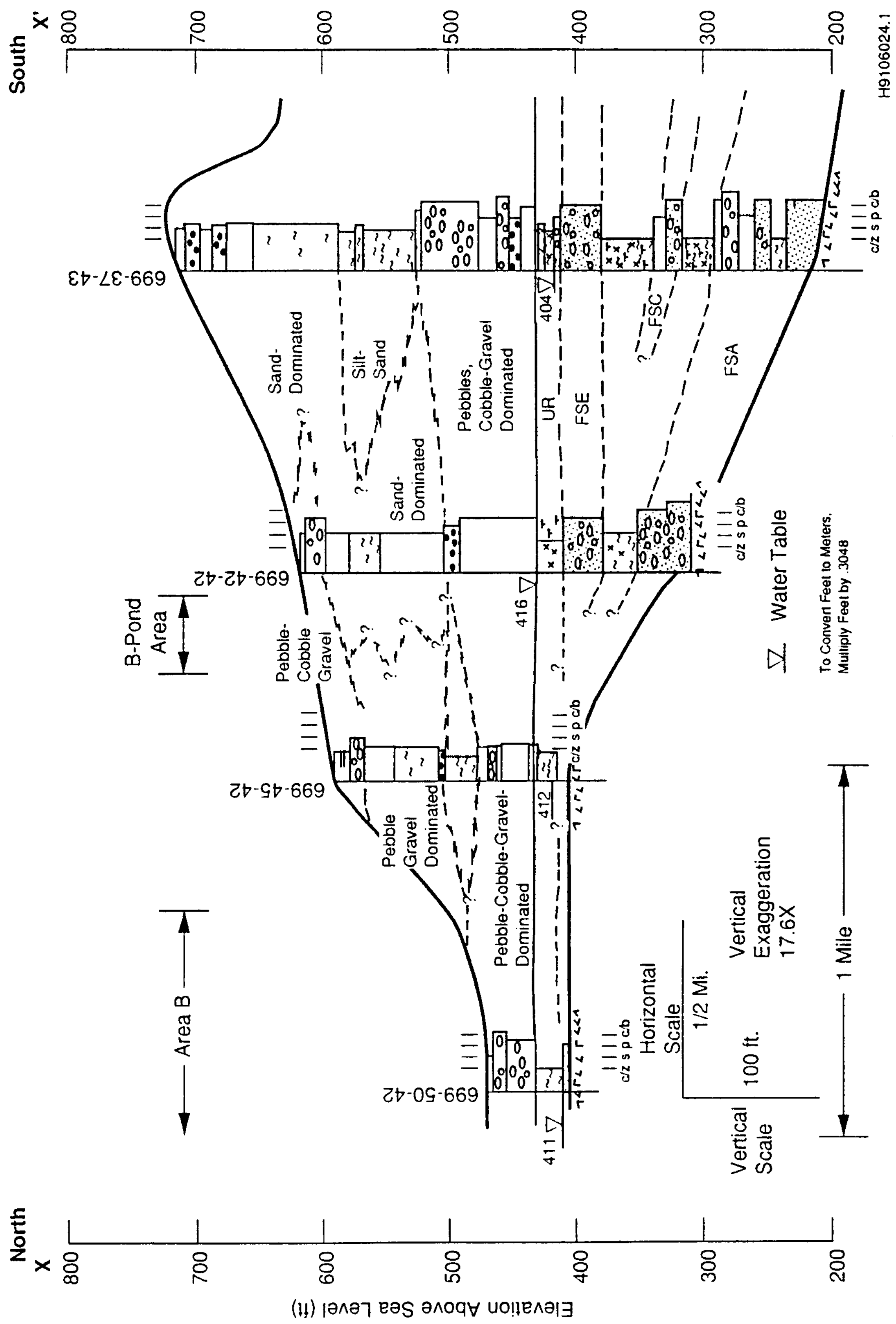

Figure A.1.5 Geologic Cross Section X-X'.

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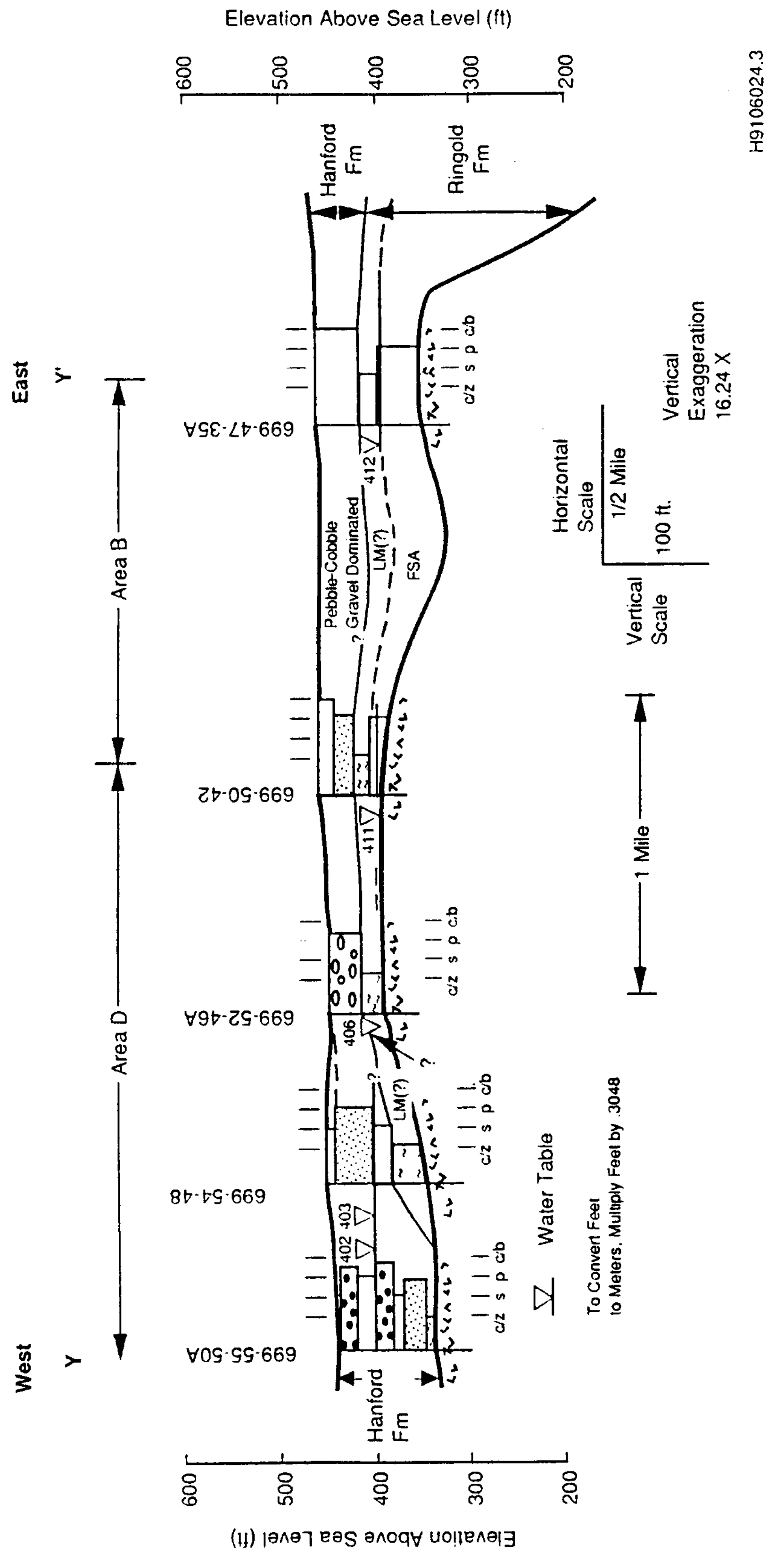

Figure A.1.6 Geologic Cross Section Y-Y'.

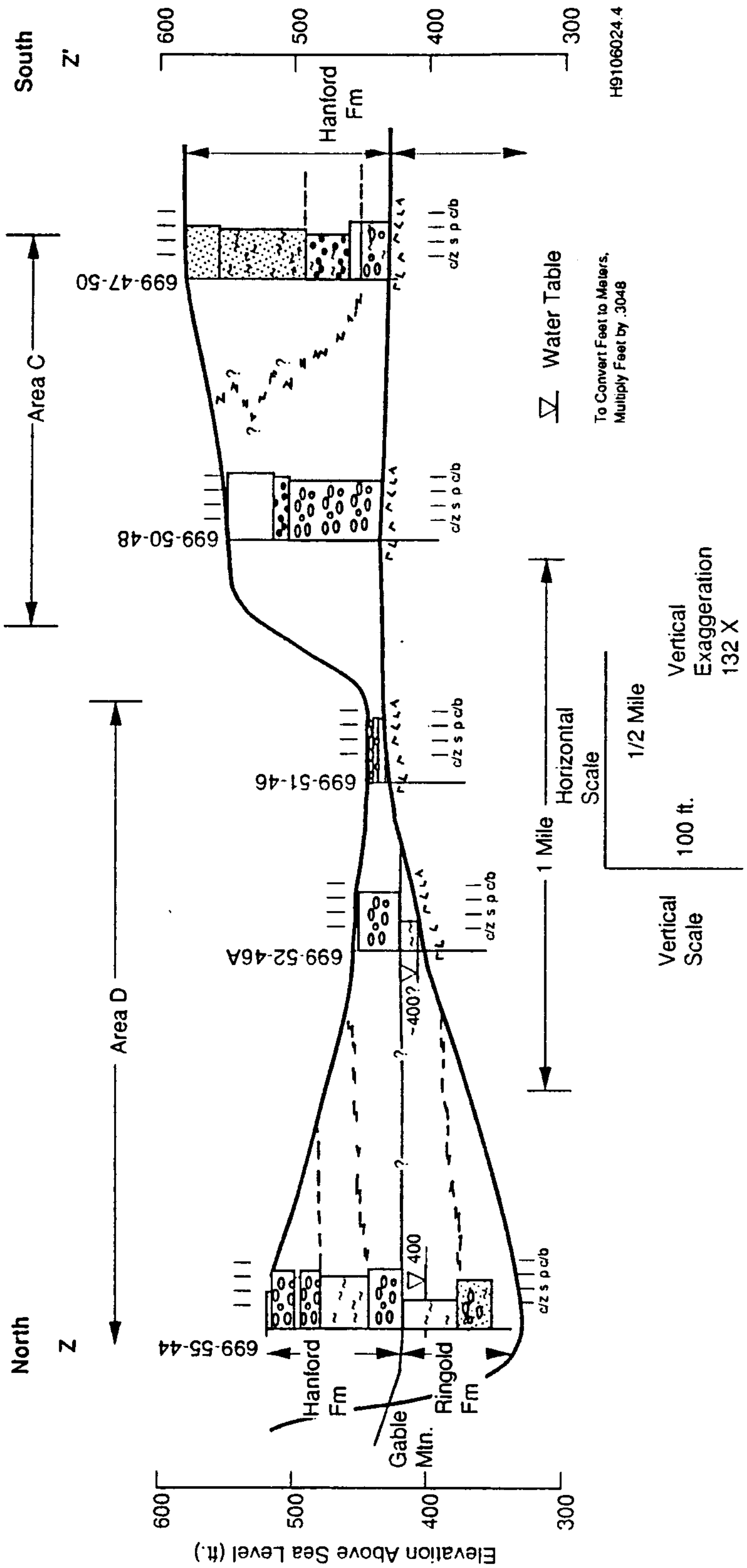

Figure A.1.7 Geologic Cross Section Z-Z'.

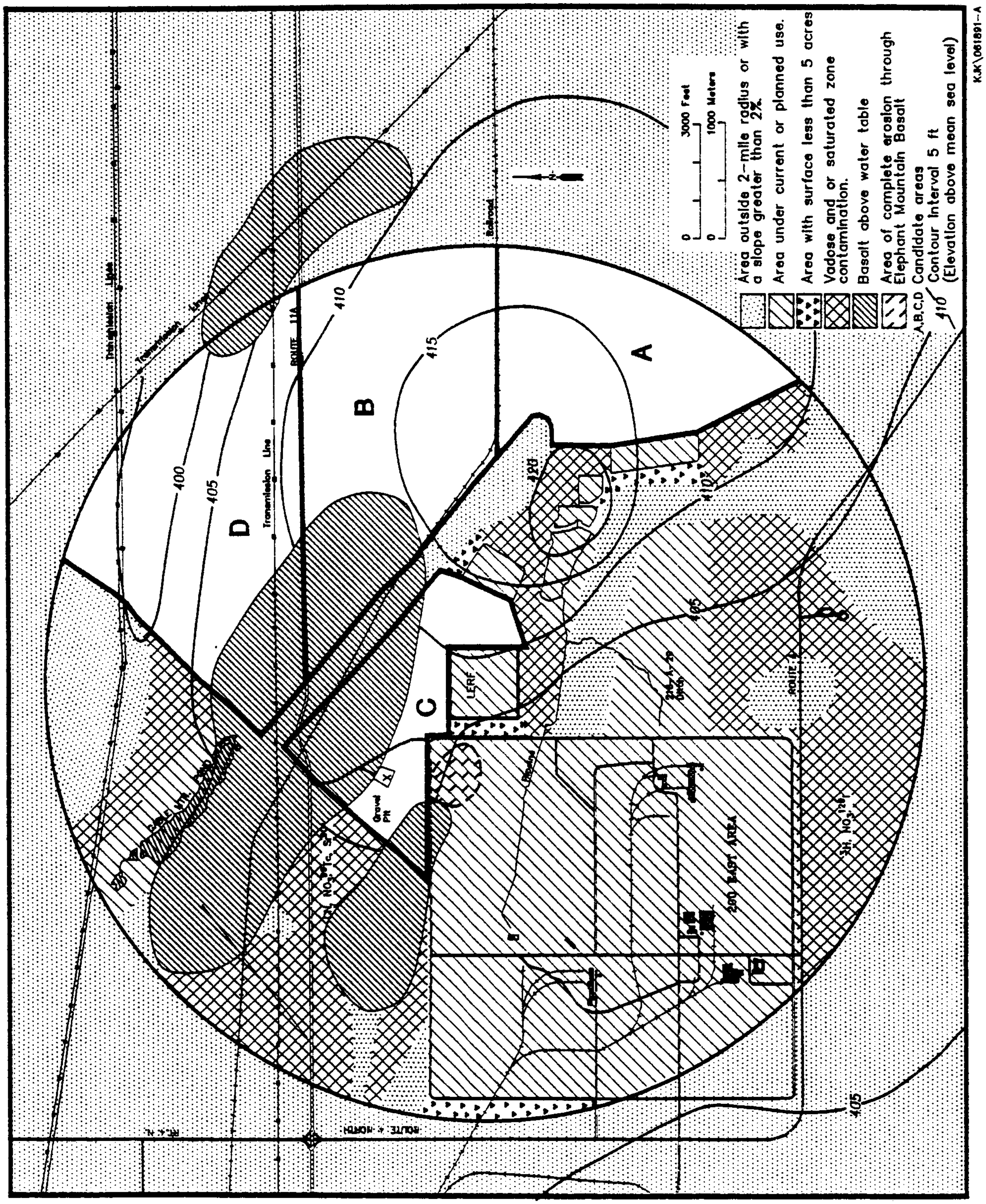

Figure A.1.8 Areas of Basalt Above the Water Table and Erosion through Elephant Mountain Basalt. (Water table elevations in feet above mean sea level).

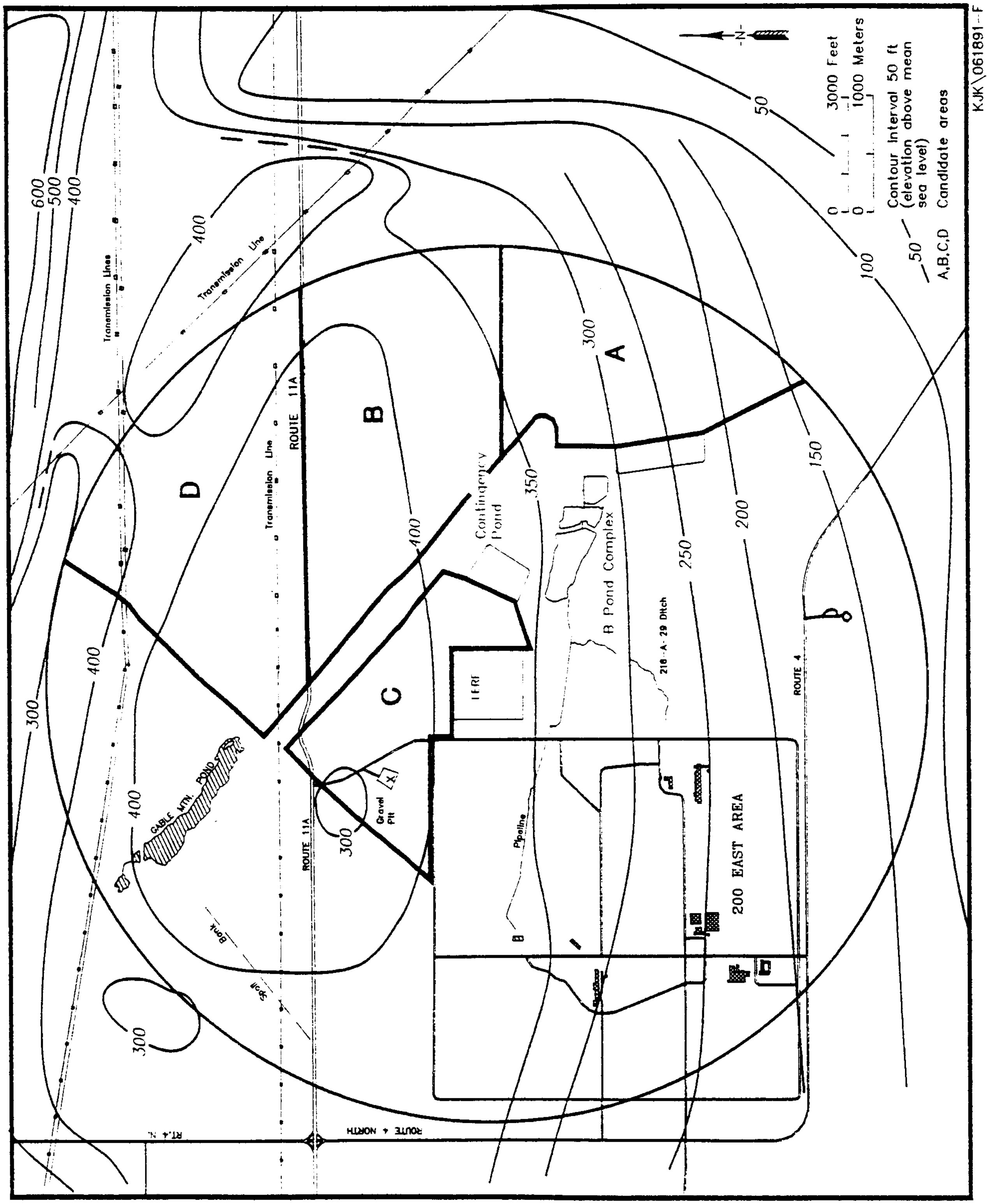

Figure A.1.9 Structure Contour Map of the Top of Basalt Beneath the Candidate Areas.

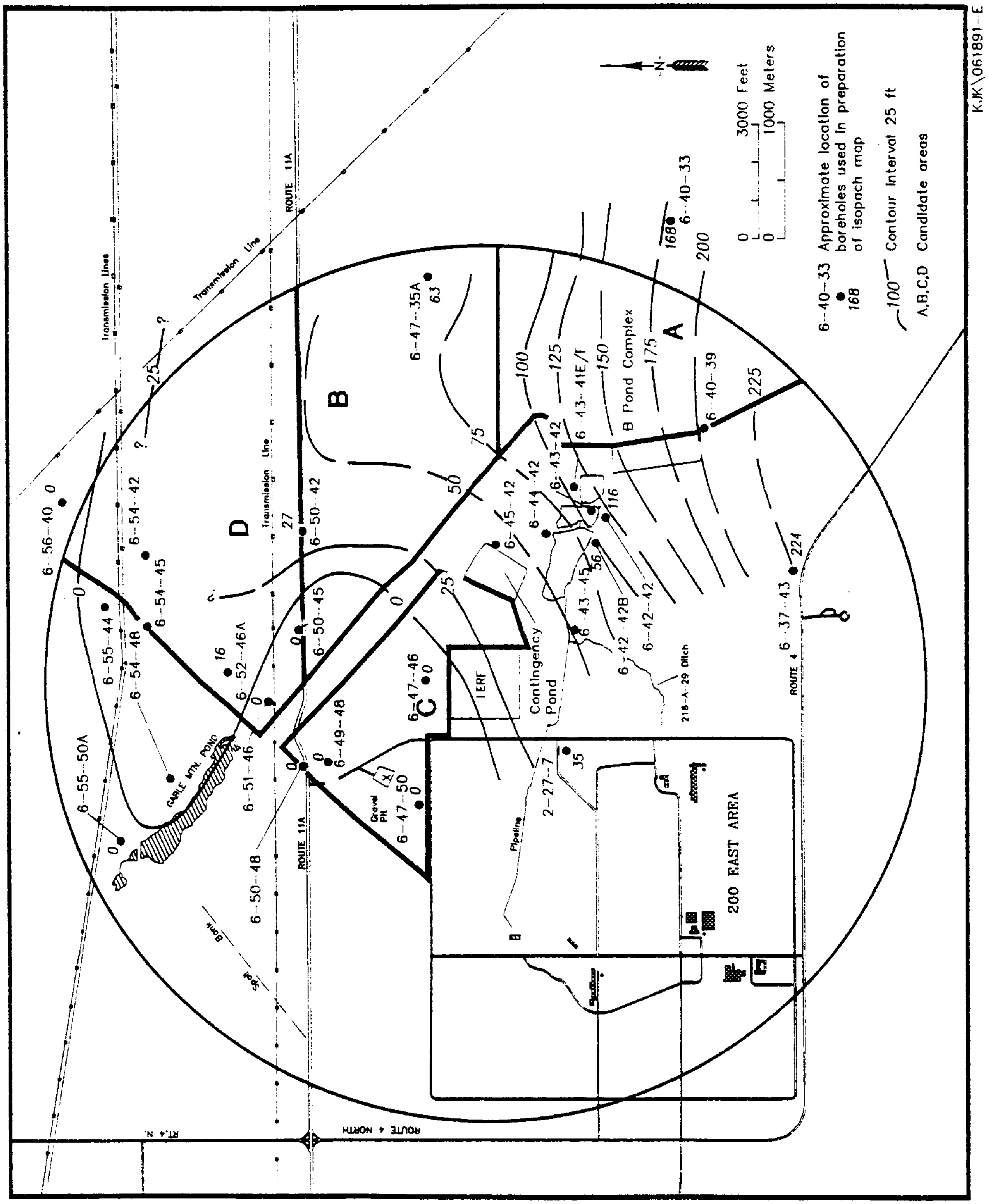

Figure A.1.10 Isopach Map of the Ringold Formation.

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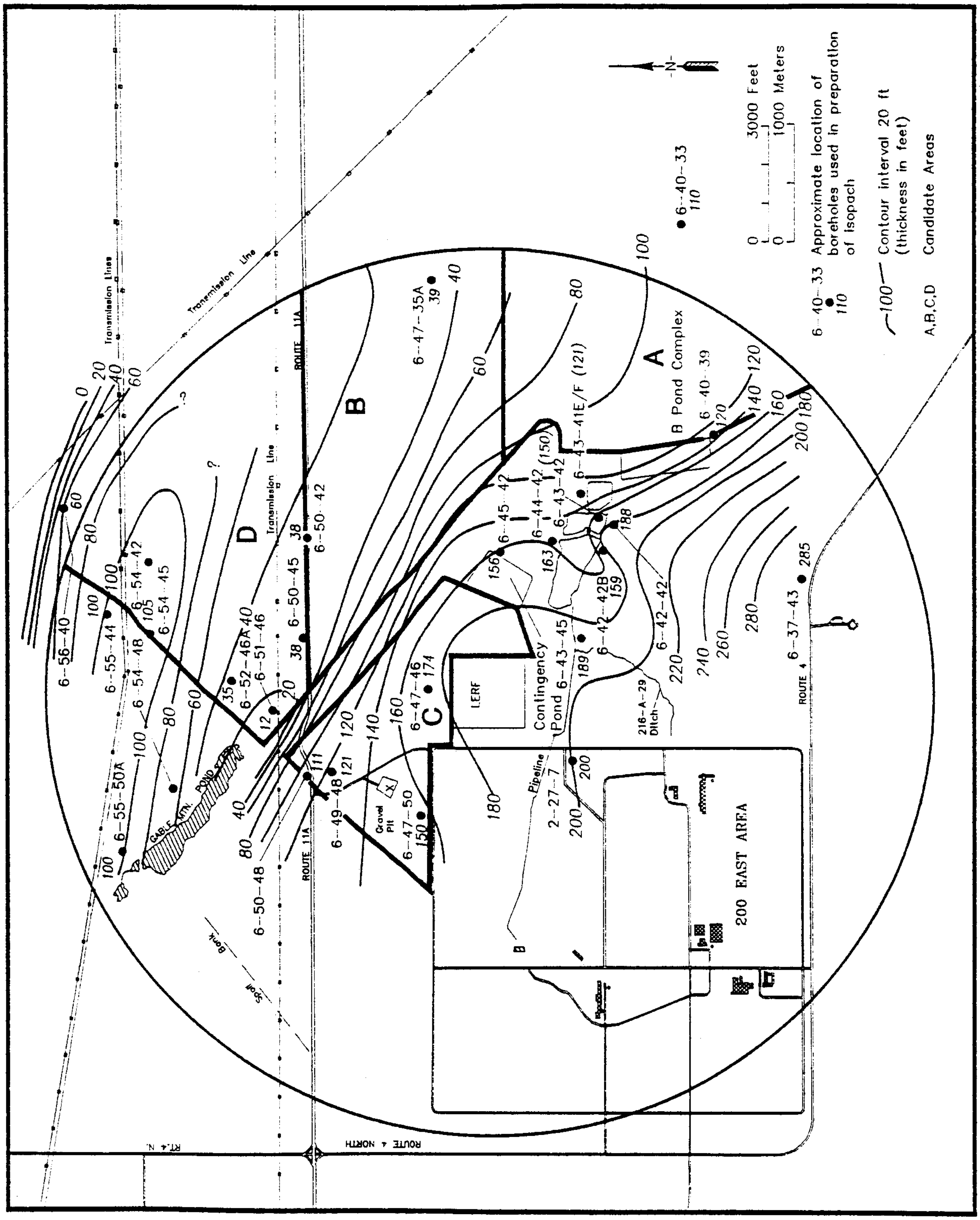

Figure A.1.11 Isopach Map of the Hanford Formation.

A.2 LOCATIONS OF CONTAMINATION

A.2.a General Areas of Surface and Subsurface Radioactive Contamination

The figures that follow (Huckfeldt 1991) show the known areas of surface and subsurface contamination associated with the 200 Areas (Figures A.2.1 and A.2.2). Also shown are areas in which widely scattered speck-sources of surface contamination have been detected and areas in which surface contamination appears to be migrating to the subsurface. Results of the simulations of hydrologic effects from operating the 200 Areas TEDB at each reference candidate site (Appendix A.3) were compared to the contaminant location maps shown here to assess the potential for negative, neutral, or positive effects.

A.2.b Radioactive Contamination of the Unconfined Aquifer

Figures A.2.3 through A.2.7 depict the estimated (Evans et al. 1990) distribution of radioactive contaminants in the unconfined aquifer in the vicinity of the 200 East Area. Contamination of the aquifer by Cesium-137 is confined to the central part of the 200 East Area (Figure A.2.3). Figure A.2.4 shows that contamination by Iodine-129 is present in the southeast corner of the 200 East Area. Contamination by Sr-90 is restricted to mostly within the 200 East Area fence, but it has also been detected beneath Gable Mountain Pond. Technetium-99 occurs immediately north of the 200 East Area. A large plume of tritium-contaminated ground water emanates from the southeast quadrant of the 200 East Area and has migrated downgradient, to the southeast.

A.2.c Non-radioactive Contamination of the Unconfined Aquifer

The unconfined aquifer has been contaminated by ferrocyanide compounds immediately north of the 200 East Area (Figure A.2.8). Nitrate contamination (Figure A.2.9) occurs in roughly the same place, within the southeast quadrant of the 200 East Area, and to the southeast. Uranium contamination is mostly confined to the northwest part of the 200 East Area (Figure A.2.10).

A.3 COMPUTER SIMULATONS OF THE PROJECTED HYDROLOGIC EFFECTS OF THE 200 AREAS TREATED EFFLUENT DISPOSAL BASIN AT EACH CANDIDATE SITE

-- W. J. McMahon --

A.3.a Description of MODFLOW Software

The MODFLOW software was developed by the U. S. Geological Survey (McDonald and Harbaugh 1988) and is written in FORTRAN 77. It runs without modification on most computers that have a DOS operating system. MODFLOW has a modular structure and uses the finite-difference method to simulate flow in three dimensions. The modules are

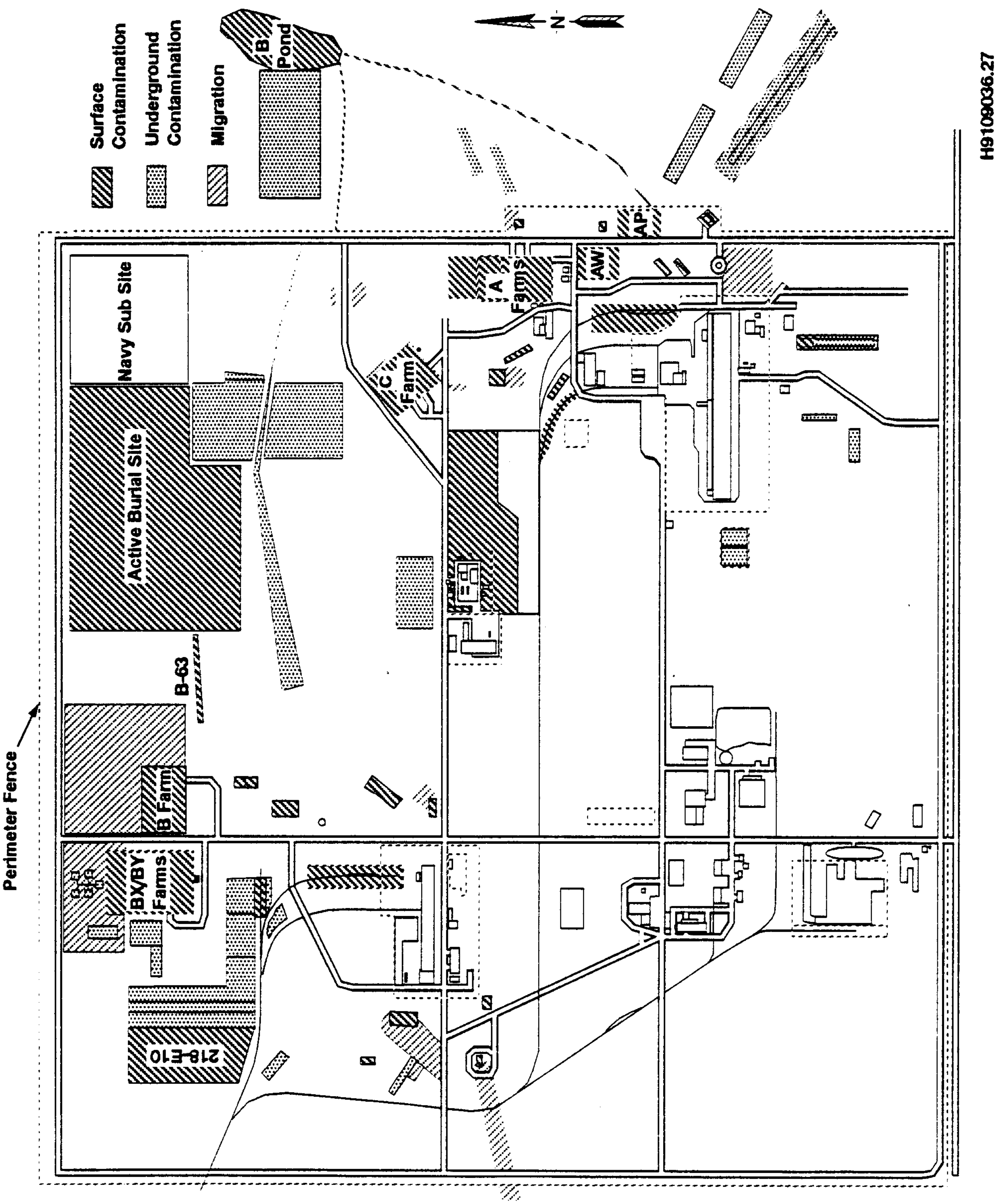

Figure A.2.1 Known Surface or Subsurface Contamination in the 200 East Area as of July 1991.

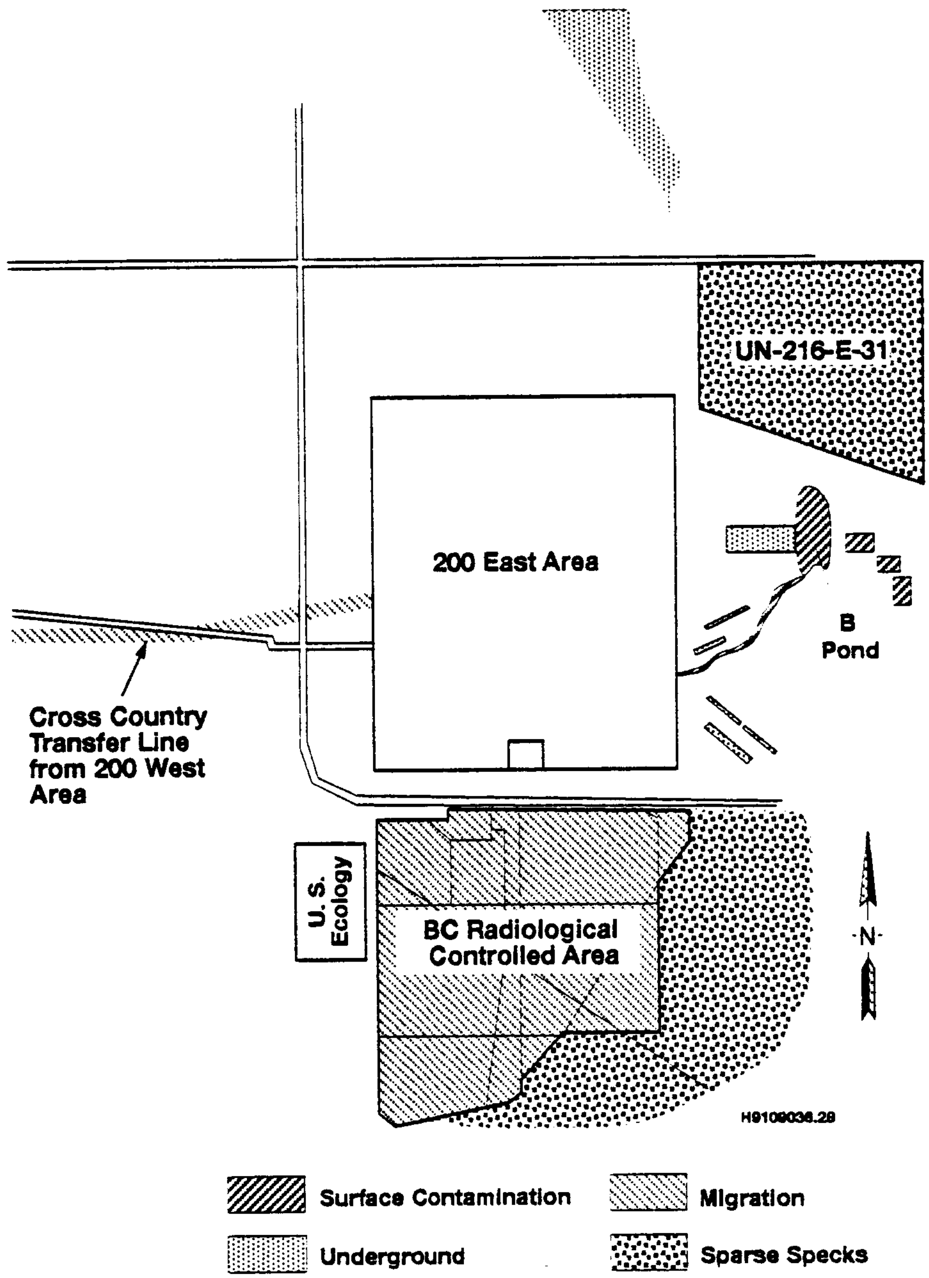

Figure A.2.2 Known Surface or Subsurface Contamination in the Vicinity of the 200 Area as of July 1991.

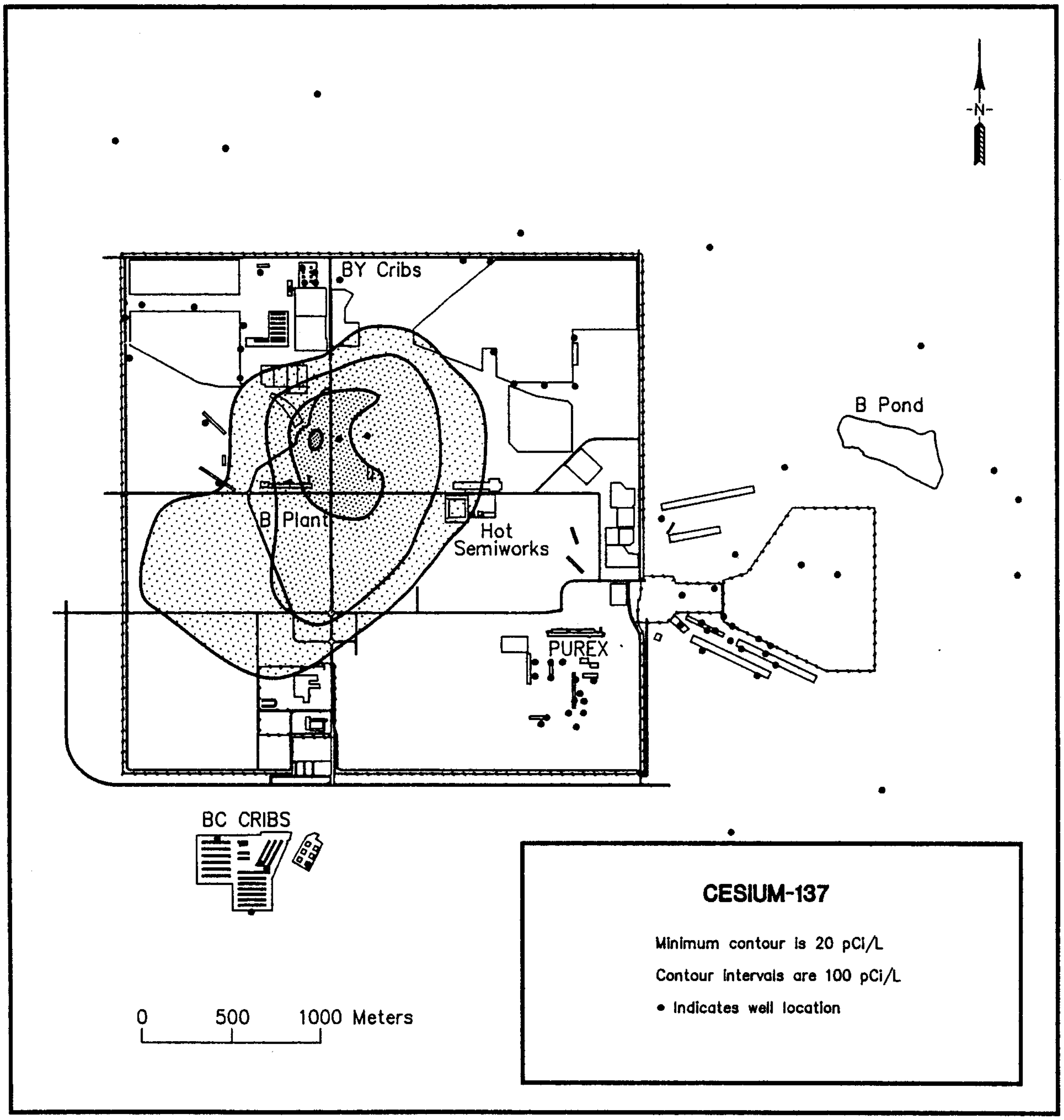

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Figure A.2.3 Cesium-137 Contamination of the Unconfined Aquifer in the 200 East Area (Evans et al. 1990).

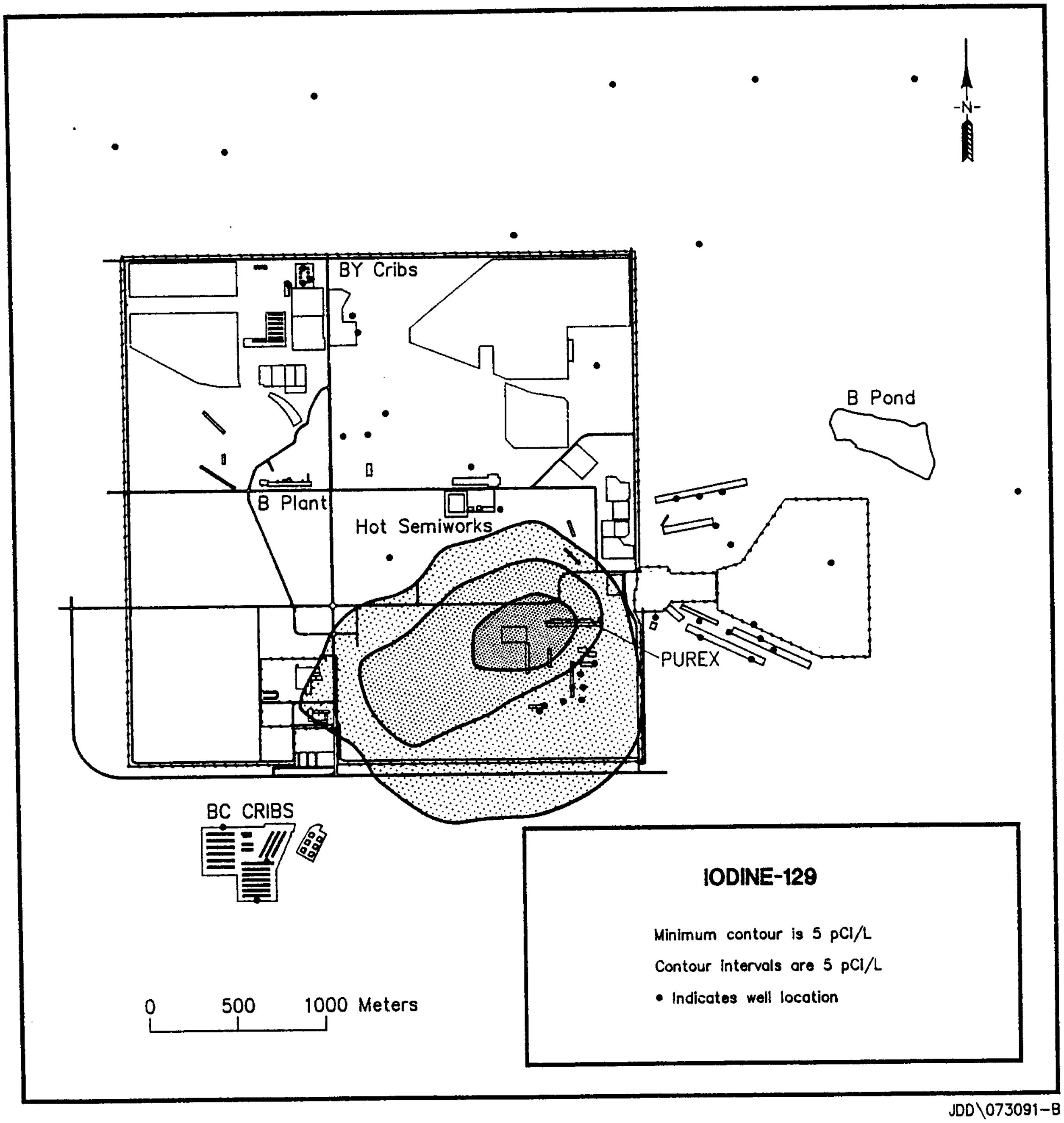

Figure A.2.4 Iodine-129 Contamination of the Unconfined Aquifer in the 200 East Area (Evans et al. 1990).

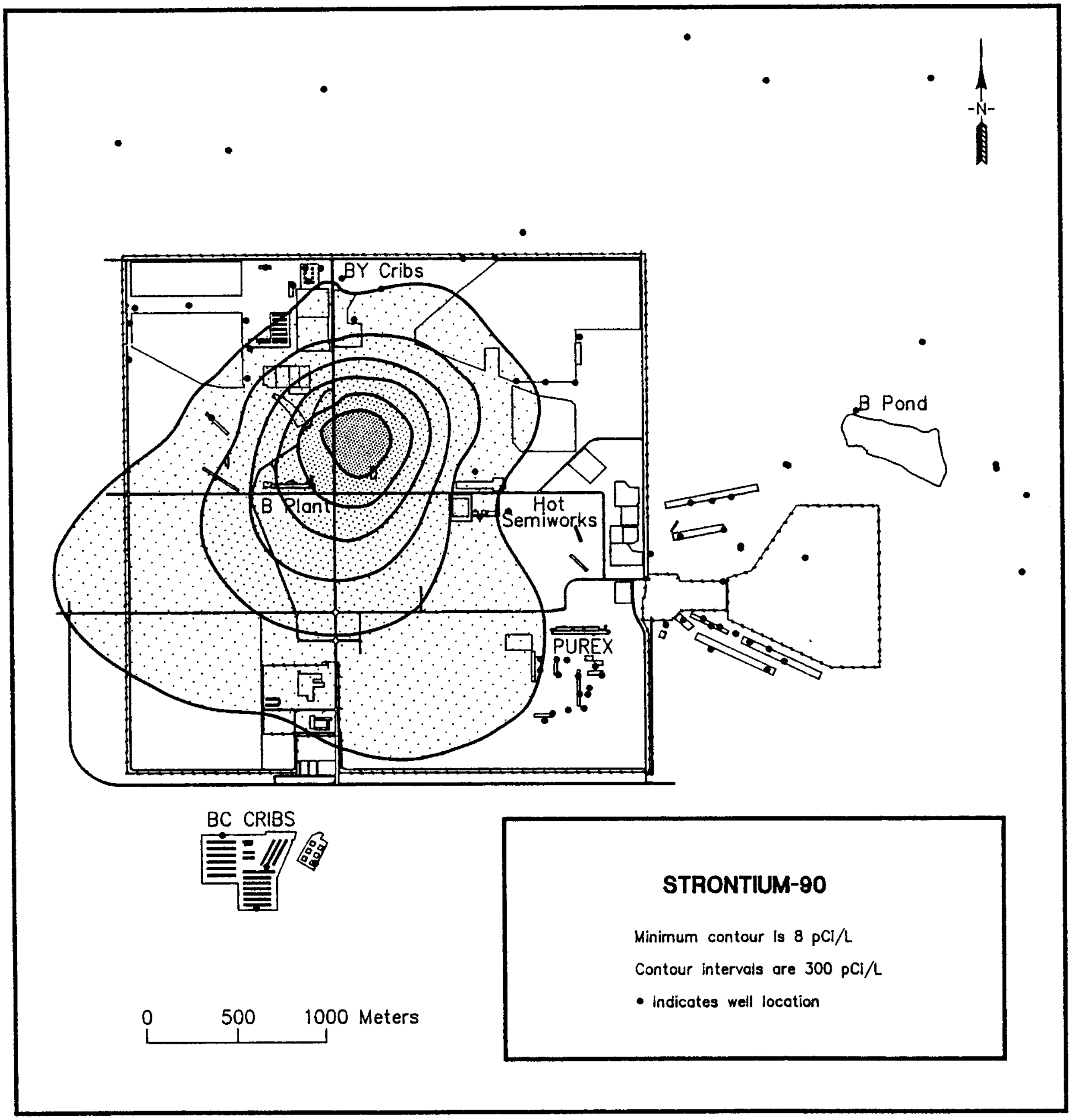

Figure A.2.5 Strontium-90 Contamination of the Unconfined Aquifer in the 200 East Area (Evans et al. 1990).

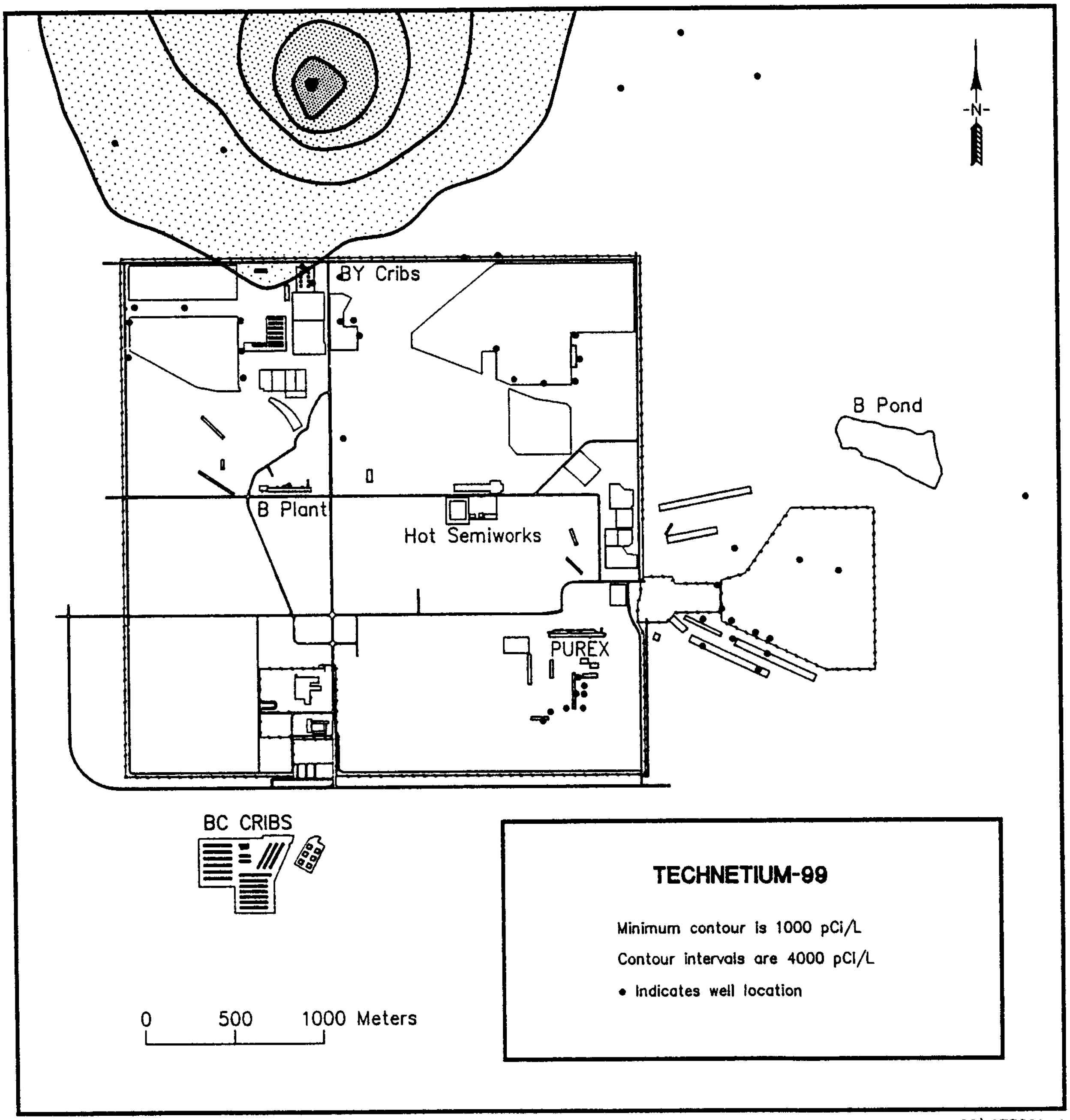

Figure A.2.6 Technetium-99 Contamination of the Unconfined Aquifer in the 200 East Area (Evans et al. 1990).

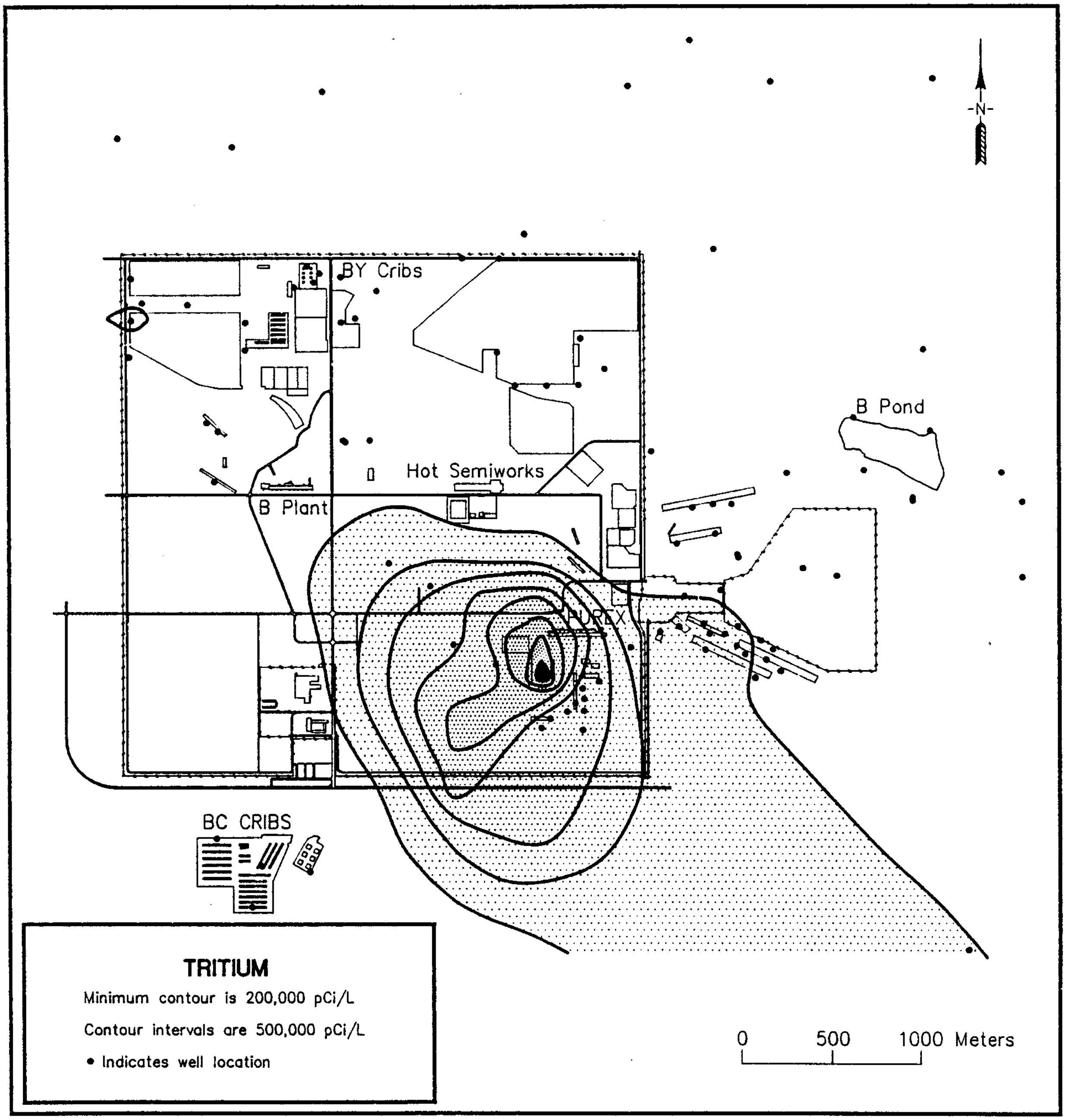

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Figure A.2.7 Tritium Contamination of the Unconfined Aquifer in the 200 East Area (Evans et al. 1990).

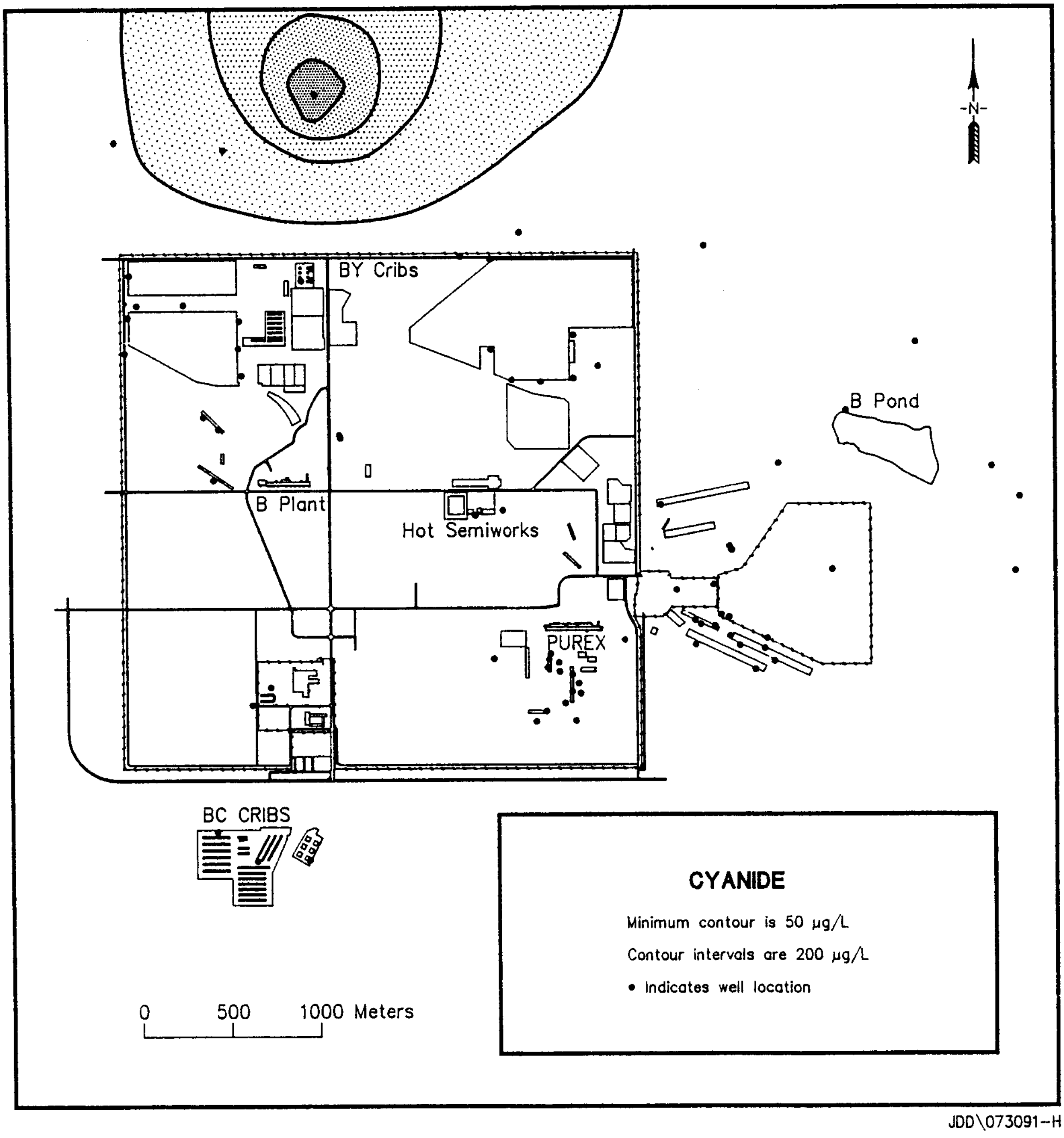

Figure A.2.8 Cyanide Contamination of the Unconfined Aquifer in the 200 East Area (Evans et al. 1990).

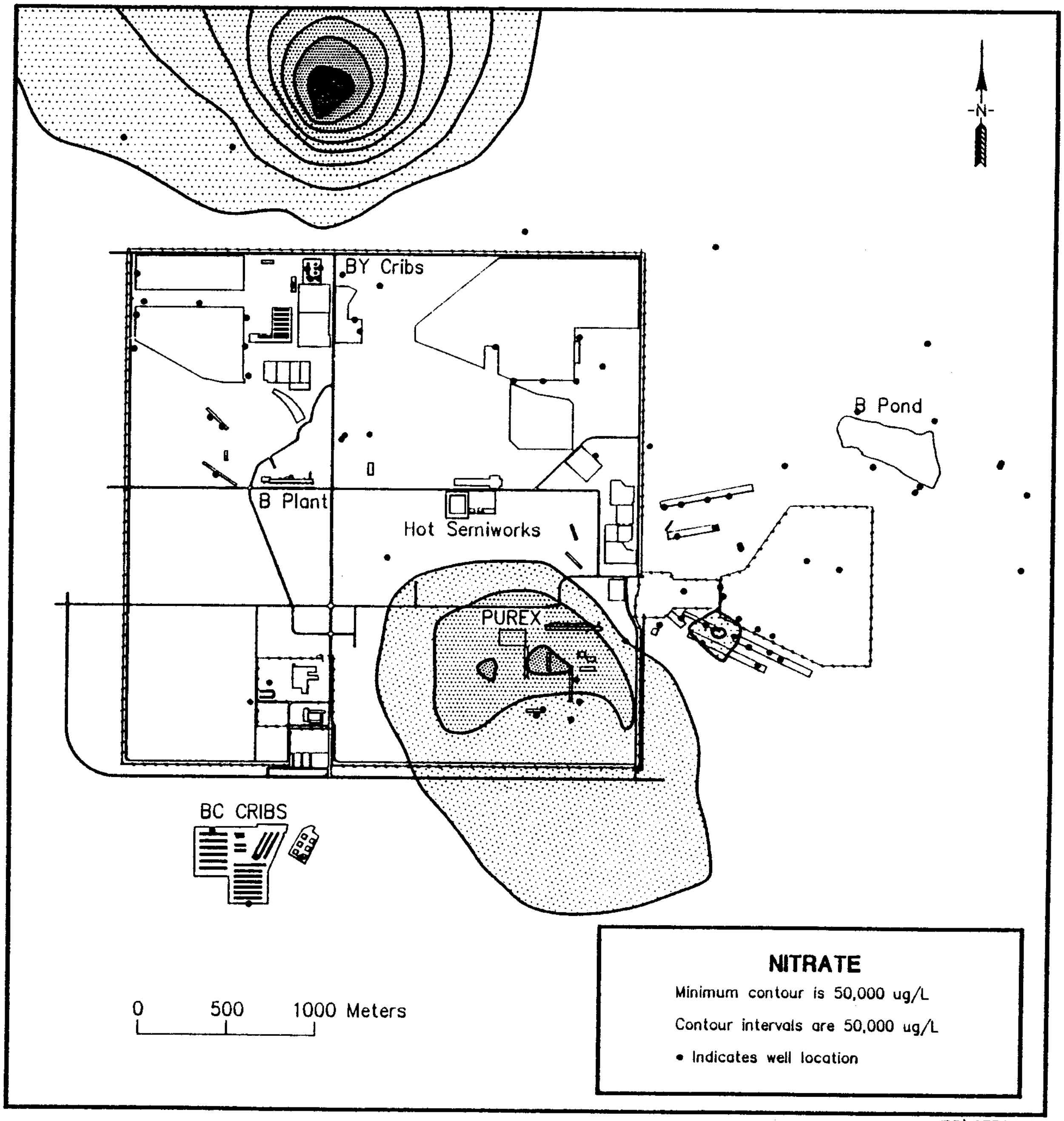

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Figure A.2.9 Nitrate Contamination of the Unconfined Aquifer in the 200 East Area (Evans et al. 1990).

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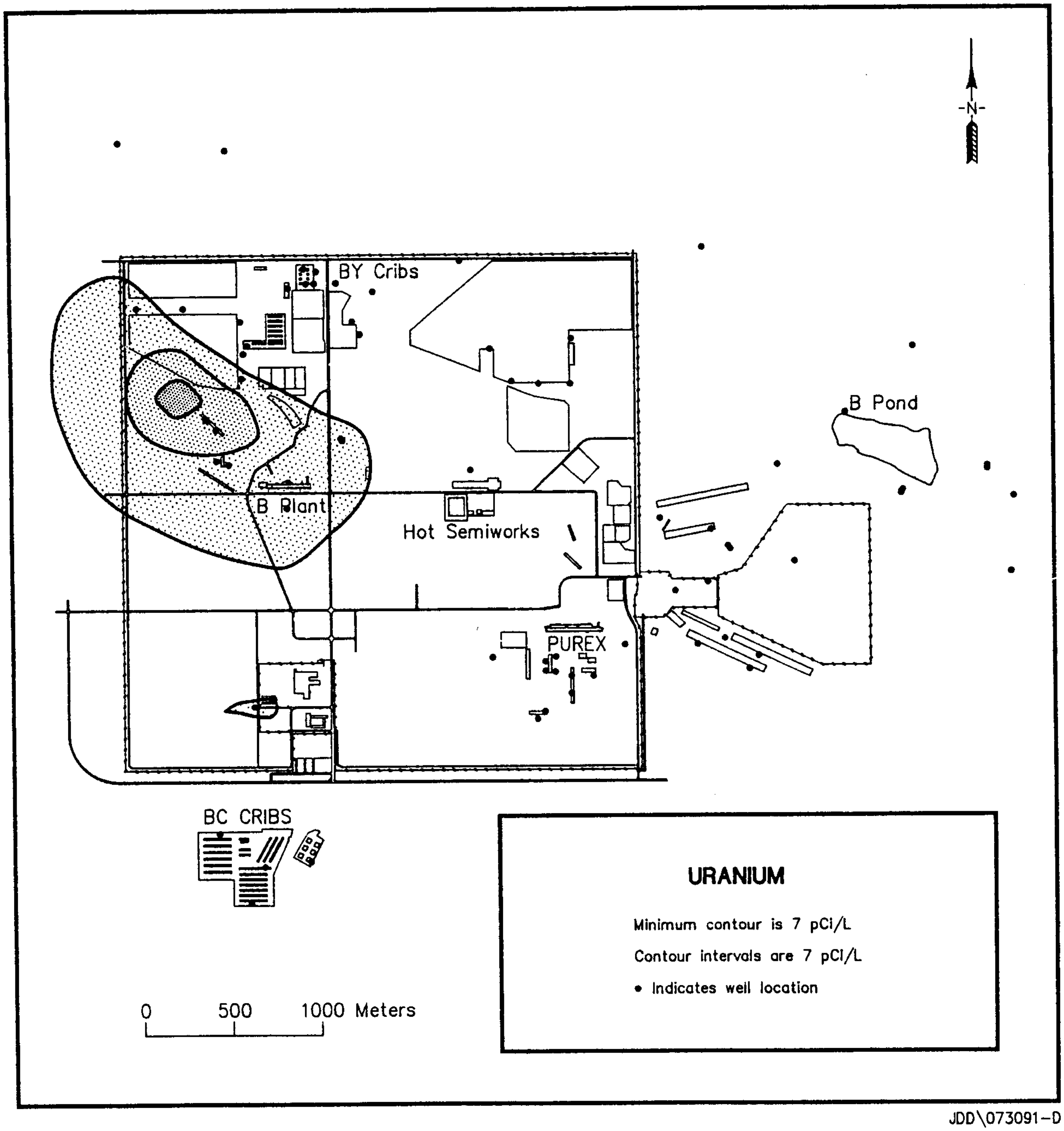

Figure A.2.10 Uranium Contamination of the Unconfined Aquifer in the 200 East Area (Evans et al. 1990).

grouped to deal either with a specific feature of the hydrologic system to be simulated or a specific method of solving linear equations that describe the flow system (e.g., the Strongly Implicit Procedure or Slice-Successive Overrelaxation). The division of the program into modules permits the user to examine specific hydrologic features independently and facilitates modification of the program.

Ground water flow within an aquifer is simulated by using a block-centered finite-difference approach. Strata can be simulated as confined, unconfined, or a combination of confined and unconfined. Flow associated with external stresses, such as wells, recharge, evapotranspiration, drains, and streams can also be simulated.

A.3.b Effects of Stratigraphy on Water Table Mounding

The simulation was performed in two steps. The first step evaluated how the differences in stratigraphy from site to site affected development of the water table mound. The second step determined the effect that infiltration of effluents from the 200 Areas TEDB would have on the preexisting water table at each of the four reference candidate sites.

The initial elevation of the water table, stratigraphy, and other pertinent hydrologic data were represented as accurately as the input structure and computational technique would allow, but were adjusted as required to operate MODFLOW. Limitations imposed by MODFLOW required oversimplification of the stratigraphy and initial position of the water table. Because of these limitations, the results of the simulations provided little differentiation between the candidate sites with respect to the size and shape of the water table mounds predicted to result from operation of the 200 Areas TEDB.

In each case, the size of the mound was shown to be highly dependent on (1) the hydraulic conductivity of the Hanford formation and (2) the flux from the 200 Areas TEDB. The results were insensitive to other input parameters. Based on the MODFLOW results, the water level directly beneath the TEDB will rise between 4 and 14 ft for a discharge rate of 1500 gpm, or 14 to 50 ft for a discharge rate of 15,000 gpm, depending on the hydraulic conductivity (10,000 and 1,000 fpd, respectively) assigned to the Hanford formation.

The major limitation of MODFLOW is that it cannot effectively simulate dry cells within the model domain. If the water level in a cell falls below the elevation of the bottom of the cell at any time, the software turns the cell off by assigning a no-flow condition to it. There are no provisions for reactivating cells; once a cell is assigned a no-flow status, that status continues for the duration simulated. As a result, the initial condition was at least partial saturation for each stratum that was simulated; consequently, the water table at the start of the time simulated was assumed to be in the Hanford formation. For this reason, the size and shape of the mounds depended mainly on the hydraulic conductivity of the Hanford formation; all of the Ringold Formation was assumed to be completely saturated at the start of each simulation. For one of the reference candidate sites, "C", this assumption is reasonable based on available hydrogeologic information. However, for sites "A", "B" and

"D", this assumption is a distortion because the water table beneath these sites is below a clayey, silty unit of the Ringold Formation. Hence, the simulations did not account for progressive mounding of the water table in this or any other unit of the Ringold Formation prior to its rising into the overlying Hanford formation.

The grid simulated consisted of 70 x 70 cells, with the TEDB located over the 16 center-most cells of the grid. The cells were square, with each side representing 369 ft; hence, the area simulated was 24 mi^2 (approximately 15,300 acres). The area of TEDB infiltration was 50 acres. The distance from the edge of the TEDB to the grid boundary was approximately 2.3 miles. The perimeter cells were assigned constant-head status based on the assumption that the water level in those cells would be beyond the direct influence of the mound. The number of strata simulated at each site varied from one to three, depending on the stratigraphic information for each site (See Appendix A.1).

Two rates of discharge into the TEDB were considered: (1) 1,500 and (2) 15,000 gpm. Recharge from the TEDB was assumed to be the only source of water to the model domain and flow through the boundaries was assumed to be the only water loss. The time simulated was divided into one-year time steps.

The hydrologic system was assumed to have homogeneous and isotropic hydraulic properties within each stratum that was simulated. The Hanford formation was treated as a single unit. The Ringold Formation was subdivided into two units; one was assumed to be clayey, silty sands and the other was assumed to be coarse-grained pebbly sand. Hydraulic data used in MODFLOW for each simulated unit included hydraulic conductivity, specific yield, and storativity. To account for the movement of water between stratigraphic units, vertical hydraulic conductivity was calculated independently of MODFLOW and included as input data. The hydraulic data used for the stratigraphic units were the same for each of the four reference candidate sites.

Physical properties data for each stratum were the initial hydraulic head, whether the aquifer was confined or unconfined, and the elevations (except for the top of the uppermost unit) of the top and bottom of the model domain. All input data were assumed to remain constant throughout the duration simulated.

Parameter value estimates were based on the data in Gephart, et al. (1979). MODFLOW was run using two bracketing values of hydraulic conductivity for the Hanford formation (1,000 and 10,000 ft/day) and two bracketing values for the finer-grained unit of the Ringold Formation (0.1 and 1.0 ft/day) at the sites where it was present. The hydraulic conductivity of the coarse-grained unit of the Ringold Formation was 5 ft/day. The specific yield values used for the Hanford, coarse-grained Ringold, and fine-grained Ringold were 0.22, 0.17, and 0.10, respectivity. The storativity used for all three units was 0.001.

Vertical hydraulic conductivity was either calculated as the weighted average of the hydraulic conductivity of the two vertically adjoining strata or, if the finer-grained unit of the Ringold Formation separated the coarser-grained unit of the Ringold from the Hanford formation, the hydraulic conductivity of that unit was used. Sensitivity analyses demonstrated that changing the value of any parameter except for the hydraulic conductivity of the Hanford formation resulted in little or no change in MODFLOW results. Even changing the specific yield value for the Hanford formation (where all of the mounding was assumed to occur) caused changes only in the fifth or sixth significant digit of the calculated elevations of the water table mounds. Because the mound shape and size depended mainly on the hydraulic conductivity of the Hanford formation and the water table was assumed to be initially within that formation, the mounds predicted to result from operation of the TEDB did not appreciably vary in size from site to site.

A.3.c Stratigraphic Effects for Each Reference Candidate Site

Candidate Site "A". The simulations for candidate site "A" included three stratigraphic units, the Hanford formation and the two facies of the Ringold Formation. Interpolations from geologic cross-sections of the area resulted in approximate thicknesses as follow: Hanford formation -- 122 ft, fine-grained Ringold Formation -- 92 ft, and coarse-grained Ringold Formation -- 37 ft. For the conceptual model, the Hanford-Ringold formational contact was at an elevation of 412 ft (all elevations are above mean sea level), the coarse grained-fine grained Ringold contact at an elevation of 320 ft, and the Ringold-basalt contact at 283 ft.

According to the water table map of the area, the water table is currently at the Hanford-Ringold formational contact; consequently, the initial condition used in MODFLOW for the elevation of the water table was 413 ft. The results of the simulation are given in Table A.3.1. The tabulated results are shown graphically in Figure A.3.1. The maximum distance from the TEDB (12,177 ft) listed in the table was the cell adjacent to the grid boundary. At the boundary, the initial elevation of the water table was fixed at 413 ft, as noted in the table in brackets.

Candidate Site "B". Simulating the projected effects of siting the TEDB at candidate site "B" presented difficulties in that, although the geologic data indicated the presence of three strata as at site "A", the water table is at the contact of the two facies of the Ringold Formation. To simulate three strata using MODFLOW, the water table would have had to be artificially elevated to the Hanford-Ringold formational contact or all of the cells in the top layer of the model domain would have immediately been set by MODFLOW to a no-flow status.

Consequently, the stratigraphy of candidate site "B" was simulated as if it consisted of two units with vastly different hydrologic properties: (1) a 65-ft-thick Hanford formation that included the fine-grained facies of the Ringold Formation and (2) the coarse-grained facies of the Ringold Formation (60-ft thick). The vertical hydraulic conductivity between the two units was calculated based on the hydraulic conductivity of the less-permeable, finer-grained facies of the Ringold Formation.

Table A.3.1 Profile of Water Table Elevations at Candidate Site "A".

SITE A								
1500 GPM								
Hydraulic Conductivity (ft/day)			Distance from Center of Pond Recharge (ft) and Water Table Elevation (ft) [413]					
Hanford	Finer Ringold	Coarser Ringold	0	369	1845	5535	9225	12,177
1000	0.1	5	426.9	426.2	421.9	416.8	414.2	413.1
1000	1.0	5	426.8	426.2	421.9	416.7	414.1	413.1
10,000	0.1	5	416.7	416.5	415.2	413.6	413.1	413.0
10,000	1.0	5	416.7	416.5	415.2	413.6	413.1	413.0
15,000 GPM								
1000	0.1	5	463.1	461.3	449.0	434.9	425.9	417.9
1000	1.0	5	462.9	461.1	448.8	434.6	425.7	417.6
10,000	0.1	5	427.4	426.8	422.6	417.6	414.9	413.3
10,000	1.0	5	427.3	426.7	422.5	417.6	414.9	413.3

This conceptual model of candidate site "B" allowed the water table to be initially at its observed elevation (411 ft), but it ignored storage in the unsaturated, fine-grained facies of the Ringold Formation. The Hanford-Ringold formational contact occurs at 433 ft, but was assigned in MODFLOW an elevation of 410 ft, which actually is where the finer-grained and coarser-grained units of the Ringold Formation are in contact. The Ringold-basalt contact is at an elevation of 350 ft and is the bottom of the model domain. Table A.3.2 summarizes the results of the simulation for candidate site "B". Figure A.3.2 graphically portrays the information shown in the table.

<u>Candidate Site "C".</u> The effects from siting the TEDB at candidate site "C" was the simplest of the four sites to simulate using MODFLOW. The information shown by the geologic cross sections indicates that the Ringold Formation is mostly absent in this area and the Hanford formation extends from the ground surface to the underlying basalt. The elevation of the water table corresponds approximately to the top of the basalt, with little, if any saturated sediment overlying the basalt. Hence, the conceptual model of site "C" consisted of a single 189-ft-thick stratigraphic unit, the Hanford formation, with its base at an elevation of 405 ft. Although this depiction of site "C" failed to reflect the presence of the Ringold Formation, the net rise in the water table varied little from that predicted for the other candidate sites (Table A.3.3 and Figure A.3.3).

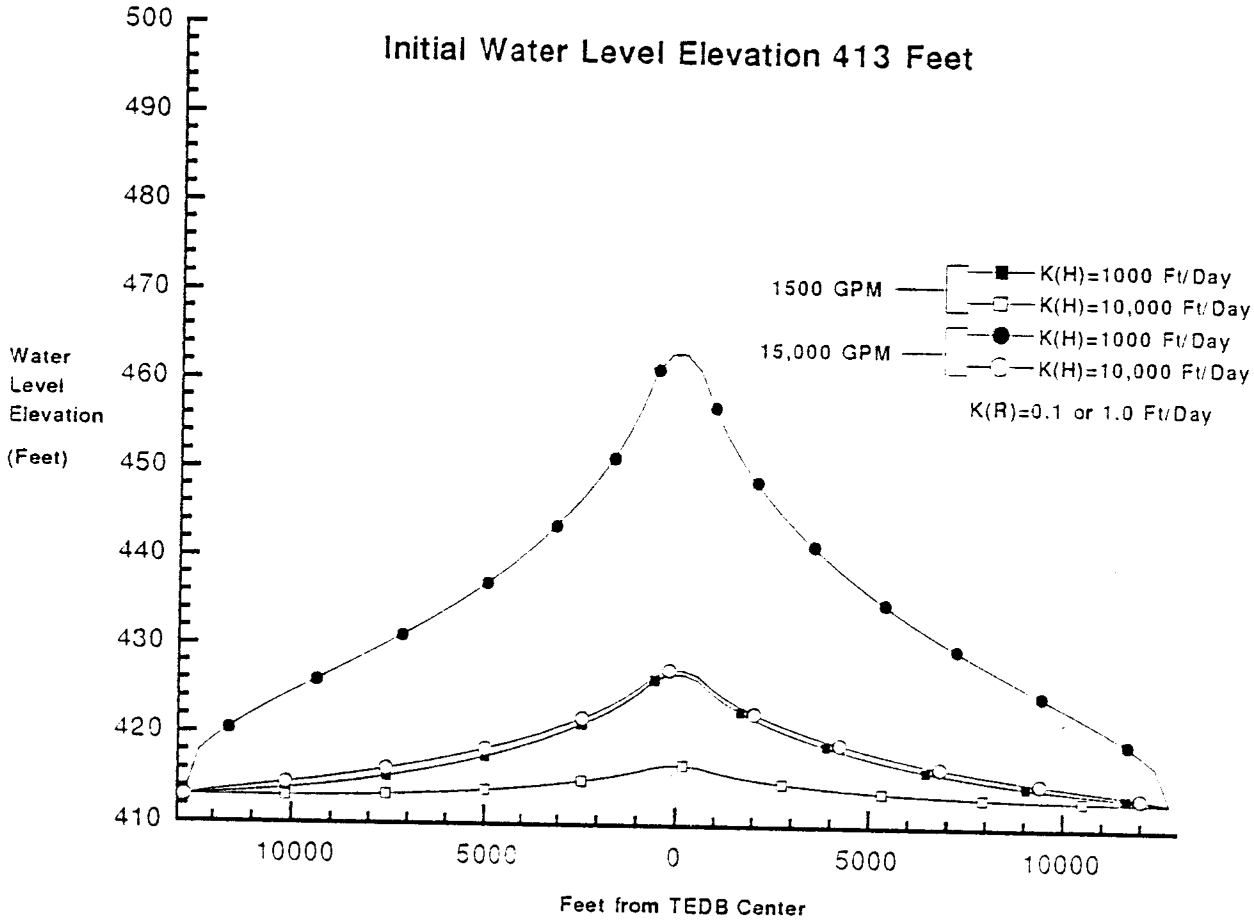

Figure A.3.1 Profile of Water Table Elevations at Candidate Site "A".

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Table A.3.2 Profile of Water Table Elevations at Candidate Site "B".

SITE B								
1500 GPM								
Hydraulic Conductivity (ft/day)			Distance from Center of Pond Recharge (ft) and Water Table Elevation (ft) [411]					
Hanford	Middle Ringold	Bottom Ringold	0	369	1845	5535	9225	12,177
1000	0.1	5	425.0	424.4	420.1	414.9	412.3	411.1
1000	1.0	5	424.9	424.3	419.9	414.8	412.2	411.1
10,000	0.1	5	414.7	414.5	413.2	411.6	411.1	411.0
10,000	1.0	5	414.7	414.5	413.2	411.6	411.1	411.0
15,000 GPM								
1000	0.1	5	461.2	459.4	447.1	432.9	424.1	416.1
1000	1.0	5	461.1	459.3	447.0	432.8	423.9	416.0
10,000	0.1	5	425.4	424.8	420.6	415.7	412.9	411.3
10,000	1.0	5	425.4	424.8	420.6	415.7	412.9	411.3

Candidate Site "D". Simulating the effects of siting the TEDB at Candidate Site "D" presented the same difficulties as for Site "B". Again, the water table is in the coarse-grained facies of the Ringold Formation and is separated from the Hanford formation by fine-grained Ringold sediments. Consequently, the same simplifications were needed as were used for Site "B".

In the conceptual model, the thickness of Hanford formation (64 ft) included the observed thicknesses of both Hanford formation (45 ft) and fine-grained Ringold Formation (19 ft); the thickness of the coarse-grained facies of the Ringold Formation was 11 ft. The geologic cross sections indicated that the Hanford-Ringold formational contact was at an elevation of 420 ft, the fine-grained to coarse-grained Ringold contact at 411 ft, and the Ringold-basalt contact at 400 ft. For the conceptual model, the contact at 420 ft was ignored and the fine-grained facies of the Ringold Formation controlled the vertical hydraulic conductivity between the units. For the conceptual model, the elevation of the water table was changed from its observed elevation of 405 ft to 412 ft to locate it within the Hanford formation. The results for Candidate Site "D" are shown in Table A.3.4 and Figure A.3.4.

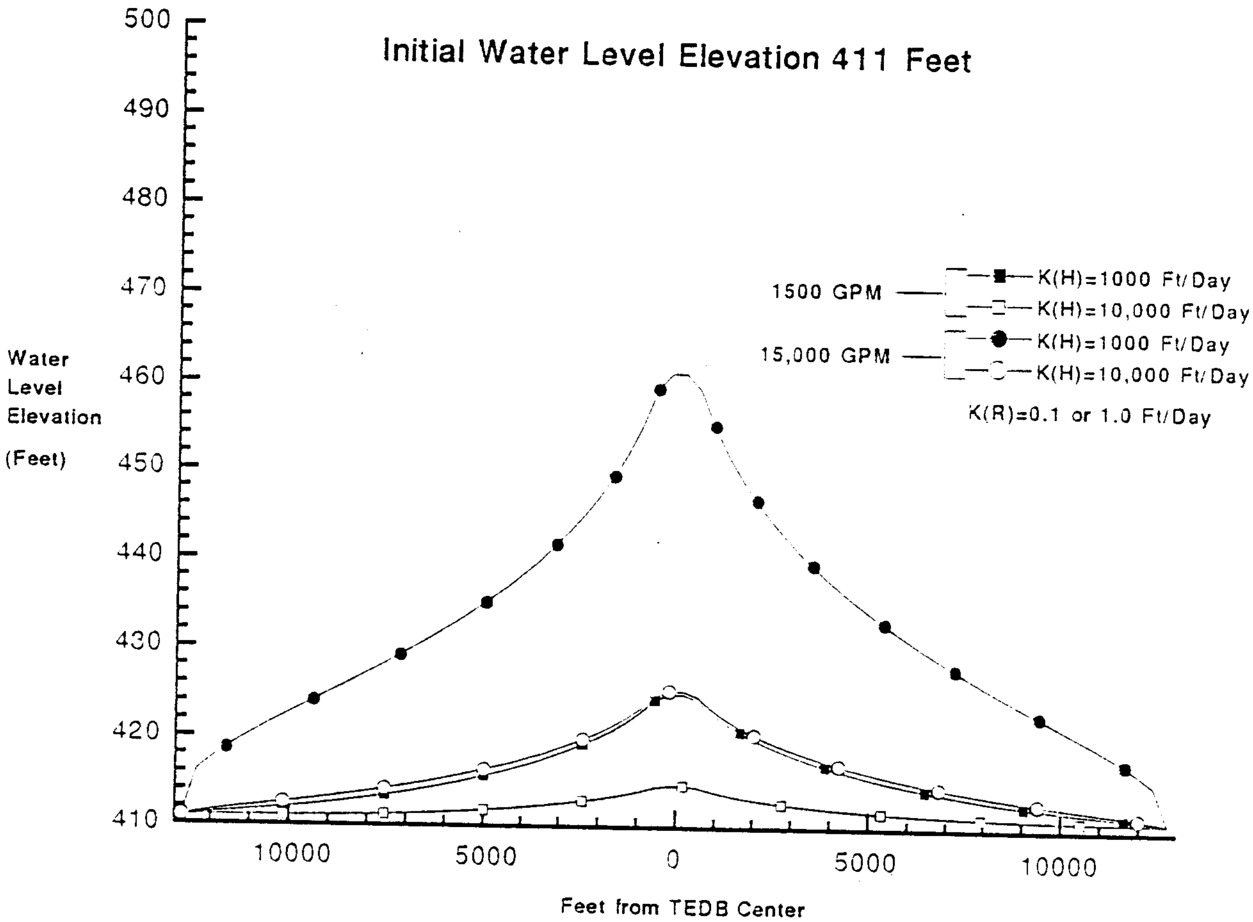

Figure A.3.2 Profile of Water Table Elevations at Candidate Site "B".

Table A.3.3 Profile of Water Table Elevations at Candidate Site "C".

SITE C						
1500 GPM						
Hydraulic Conductivity (ft/day)	Distance from Center of Pond Recharge (ft) and Water Table Elevation (ft) [405]					
Hanford	0	369	1845	5535	9225	12,177
1000	419.6	419.0	414.7	409.6	407.0	405.4
10,000	409.2	409.0	407.6	406.0	405.2	405.0
15,000 GPM						
1000	455.2	453.5	441.2	427.0	418.2	410.2
10,000	419.4	418.8	414.6	409.7	406.9	405.3

A.3.d Analysis of Results

Comparison of the tables reveals that a simulated ten-fold increase in the hydraulic conductivity of the finer-grained facies of the Ringold Formation decreased the size of the water table mound by ≤0.3 ft, an insignificant amount considering the uncertainties in the input data and the simplifications of the conceptual model. Furthermore, Table A.3.3 shows that the absence of the fine-grained Ringold facies does not noticeably affect the size of the water table mound. Additional MODFLOW simulations were made to test the sensitivity of the results to changes in the hydraulic conductivity of the coarse-grained facies of the Ringold Formation. These results also indicated that changes in the hydraulic conductivity of this facies had little or no effect on the size of the water table mound and, for that reason, these results were not included in the tables.

For the simplistic conceptual input used, MODFLOW was unable to differentiate between the sites with respect to the size and shape of the water table mounds. At the points listed in the tables, the maximum differences in mound heights for the candidate sites were 0.6 ft for a given hydraulic conductivity of the Hanford formation and rate of infiltration from the TEDB. Table A.3.5 and Figure A.3.5 show the typical water table mound predicted by MODFLOW to result from operation of the TEDB at each of the four candidate sites.

A.3.e Water Table Mound Development

Because the results obtained from the first step of the analysis showed essentially no sensitivity to the presence of the Ringold Formation, only one unit (the Hanford formation) was used in the second step of the analysis. By considering only one, the initial water

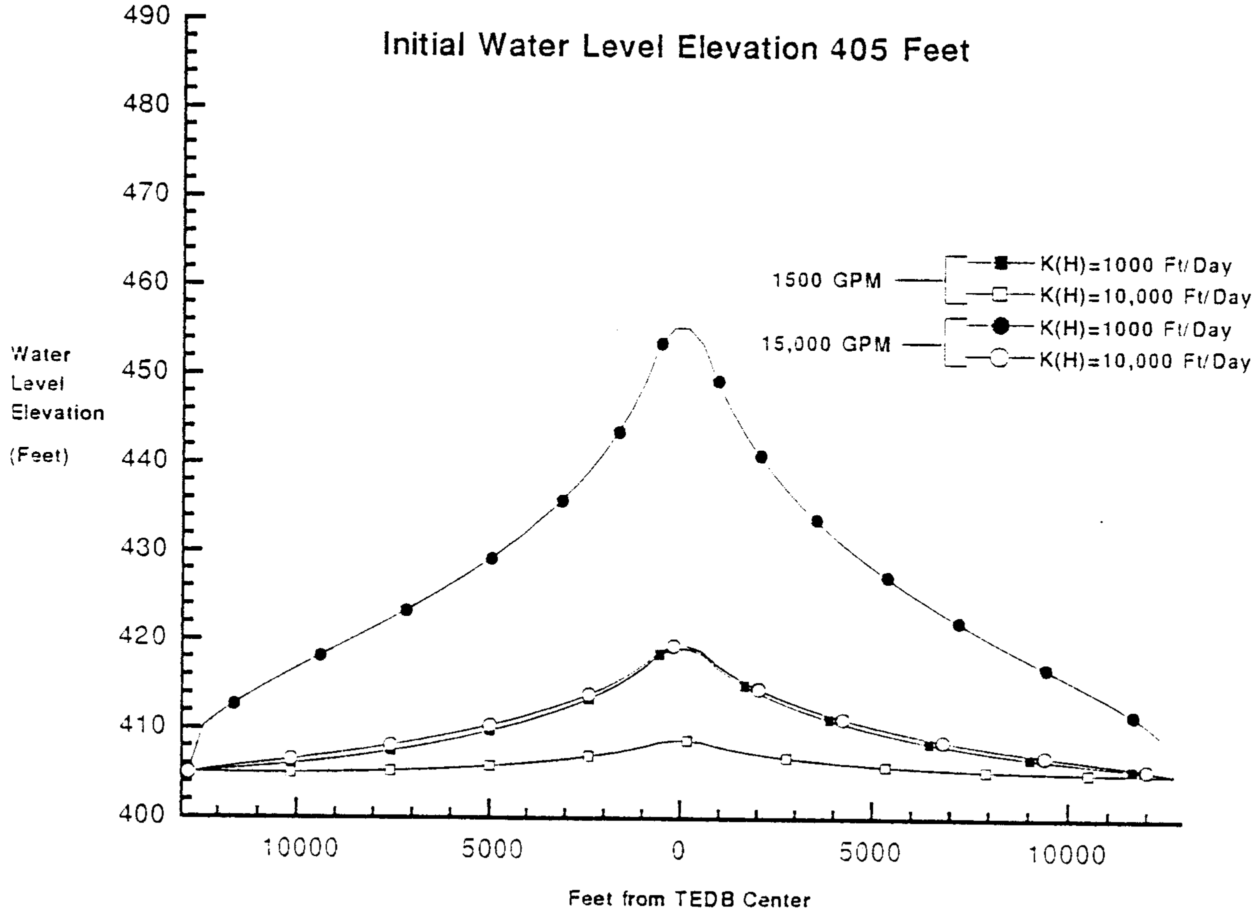

Figure A.3.3 Profile of Water Table Elevations at Candidate Site "C".

Table A.3.4 Profile of Water Table Elevations at Candidate Site "D".

SITE D								
1500 GPM								
Hydraulic Conductivity (ft/day)			Distance from Center of Pond Recharge (ft) and Water Table Elevation (ft) [412]					
Hanford	Middle Ringold	Bottom Ringold	0	369	1845	5535	9225	12,177
1000	0.1	5	426.0	425.4	421.1	415.9	413.3	412.1
1000	1.0	5	426.0	425.4	421.1	416.0	413.3	412.1
10,000	0.1	5	415.7	415.5	414.2	412.6	412.1	412.0
10,000	1.0	5	415.7	415.5	414.2	412.6	412.1	412.0
15,000 GPM								
1000	0.1	5	462.2	460.4	448.2	434.0	425.1	417.2
1000	1.0	5	462.2	460.4	448.1	434.0	425.1	417.1
10,000	0.1	5	426.4	425.8	421.6	416.7	413.9	412.3
10,000	1.0	5	426.4	425.8	421.6	416.7	413.9	412.3

level datum could be input more accurately without the causing the program to malfunction because of the inclusion of dry cells. As an additional step to prevent this kind of malfunction, the bottom of the model domain was arbitrarily defined as five feet below the lowest elevation of effluent water entering the water table. MODFLOW was run four times for each candidate site: two for each discharge rate (1,500 and 15,000 gpm) and two for each assigned hydraulic conductivity of the Hanford formation (1,000 and 10,000 ft^2/d). The value of the specific yield for all of the sites was 0.22. The data set used for the initial elevation of the water table was determined from Figure A.1.8.

The grid that was simulated was again 70 x 70 cells, but the length dimension of the edge of each cell was reduced to 250 ft to allow for better resolution of the results in the immediate proximity of the candidate sites. The total area simulated was approximately 11 mi^2 (7,000 acres). The effluent entering the water table from the TEDB was equally distributed through the thirty-six center-most cells, representing an area of about 52 acres. The distance from the edge of the TEDB to the grid boundary was 8,000 ft. The cells for these simulations were assigned no-flow or constant-head status only if available geohydrologic data indicated that this was appropriate.

The cells representing the two basalt subcrops were assigned no-flow status for two reasons. The first was that the hydraulic conductivity through the basalt is negligible

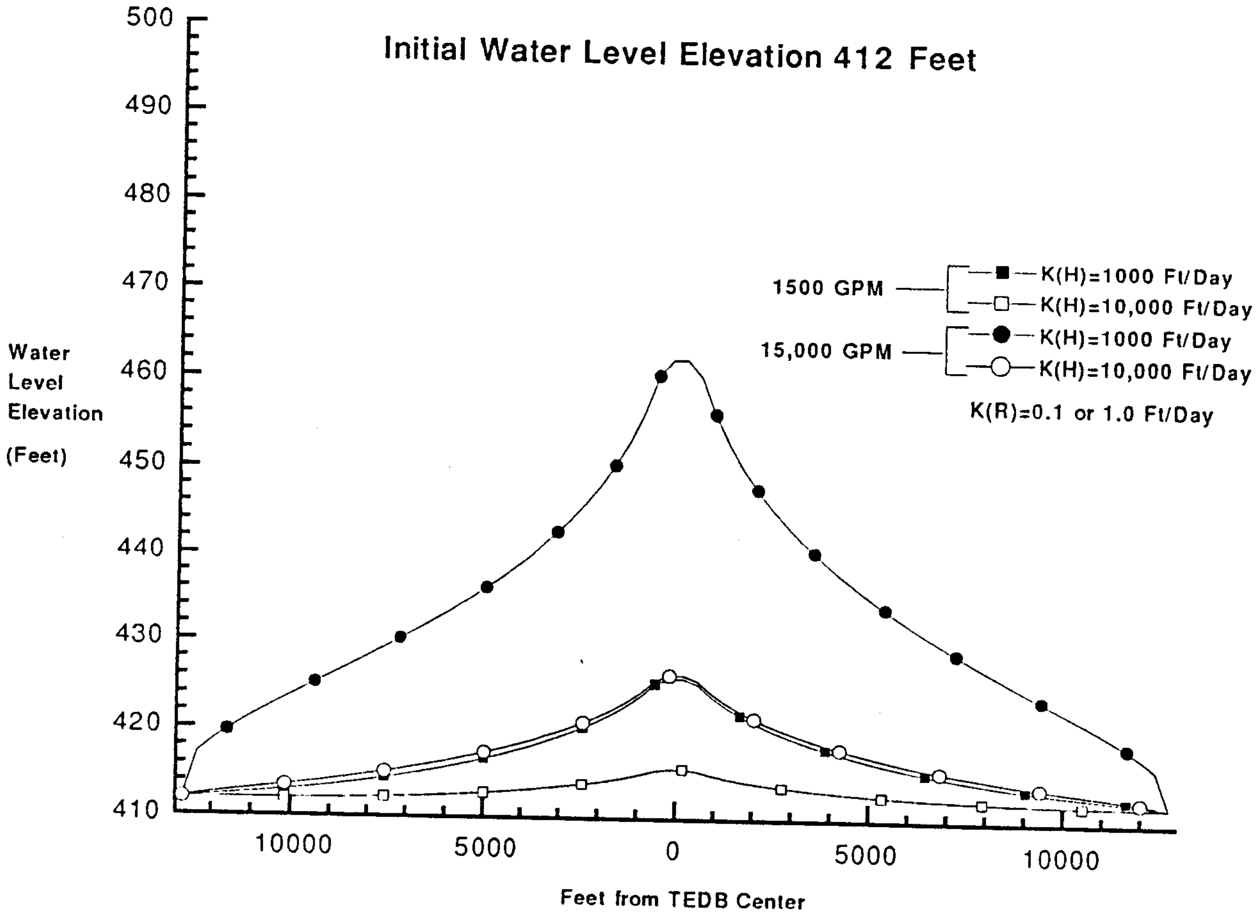

Figure A.3.4 Profile of Water Table Elevations at Candidate Site "D".

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Table A.3.5 Typical Mounding of the Water Table Predicted by MODFLOW for the Candidate Sites.

MOUND SIZE						
1500 GPM						
Hydraulic Conductivity (ft/day)	Distance from Center of Pond Recharge (ft) and Mound Height (ft) [0]					
Hanford	0	369	1845	5535	9225	12,177
1000	14.0	13.3	9.0	3.9	1.3	0.1
10,000	3.7	3.5	2.2	0.6	0.1	0
15,000 GPM						
1000	50.1	48.3	36.0	21.9	13.0	5.0
10,000	14.4	13.8	9.6	4.6	1.9	0.3

compared to that of the Hanford formation. The second is that a no-flow condition best describes the behavior of the water table in two areas of near-surface basalt, as shown in Figure A.1.8.

Candidate Site A. The rise in the water table predicted by the simulations for site "A" is shown in Figures A.3.6 through A.3.9. The results indicate that a mound in the water table would develop directly beneath and to the north of the 200 Areas TEDB if it were constructed at reference candidate site "A". The mound that currently results from effluent disposal at the B pond complex is elongated toward the northeast, and would continue to be elongated northeasterly, between the two basalt subcrops, as it gradually decays.

The predicted rise in the water table due to the infiltration of 200 Areas TEDB effluent beneath site "A" produces the highest hydraulic gradients to the south and southwest. This mound would block flow from the B pond complex to the east, toward the Columbia River. Acceleration of flow to the south would rapidly attenuate beyond the immediate influence of the mound resulting from the TEDB; the flow would lose most of its artificially elevated hydraulic gradient and then be pushed eastward by the natural gradient.

Candidate Site B. Two subcrops of relatively near-surface basalt flank candidate site "B" on the east and west. The center of the current water table mound beneath the B pond complex is about one-mile south of site "B". Because the western border of the grid is located in a hydraulic plateau, the cells on that border were assigned constant head status. The results of the simulations (Figures A.3.10 through A.3.13) showed that the mound in the water table beneath site "B" would grow toward the southeast. The two basalt subcrops would partially block lateral growth of the mound and result in the

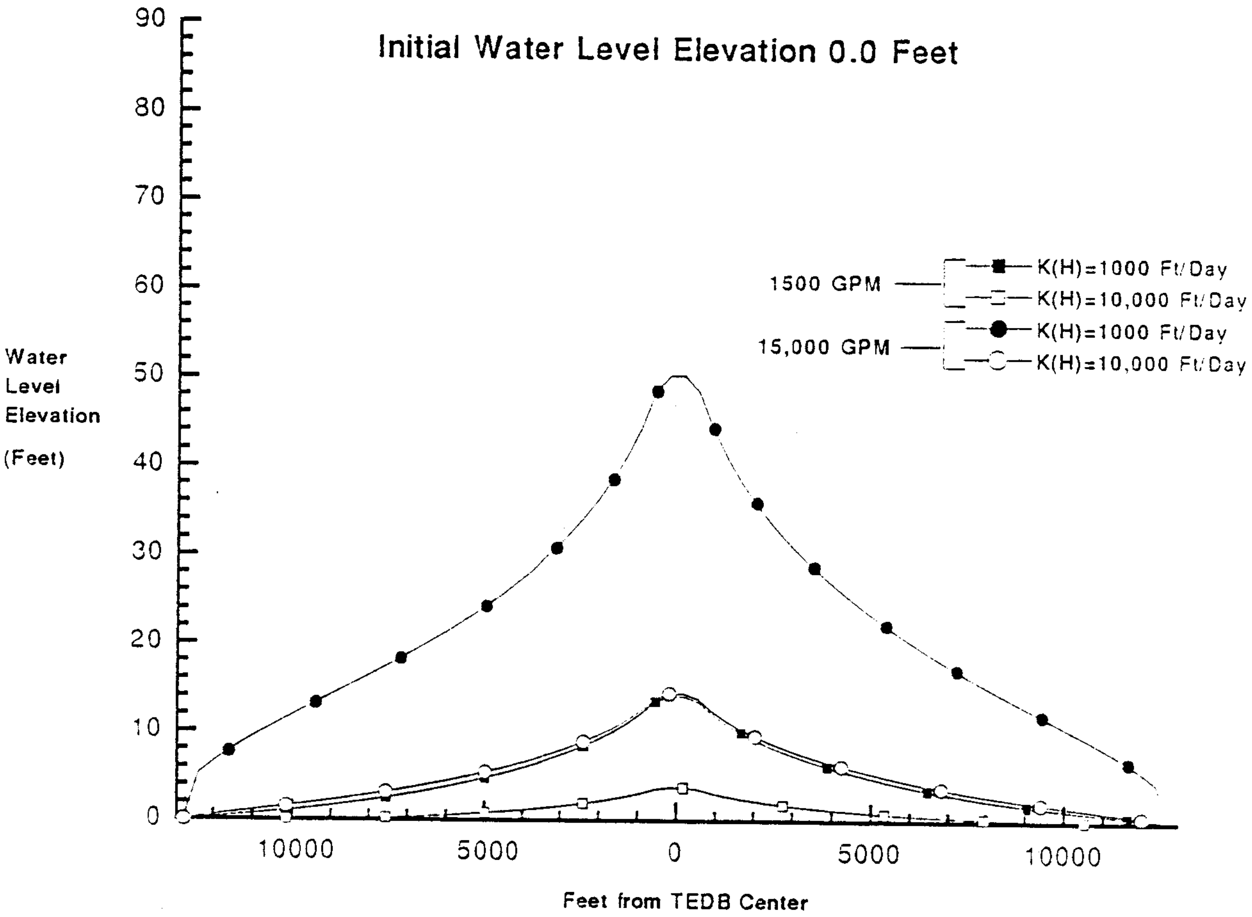

Figure A.3.5 Typical Mounding of the Water Table Predicted by MODFLOW for the Candidate Sites.

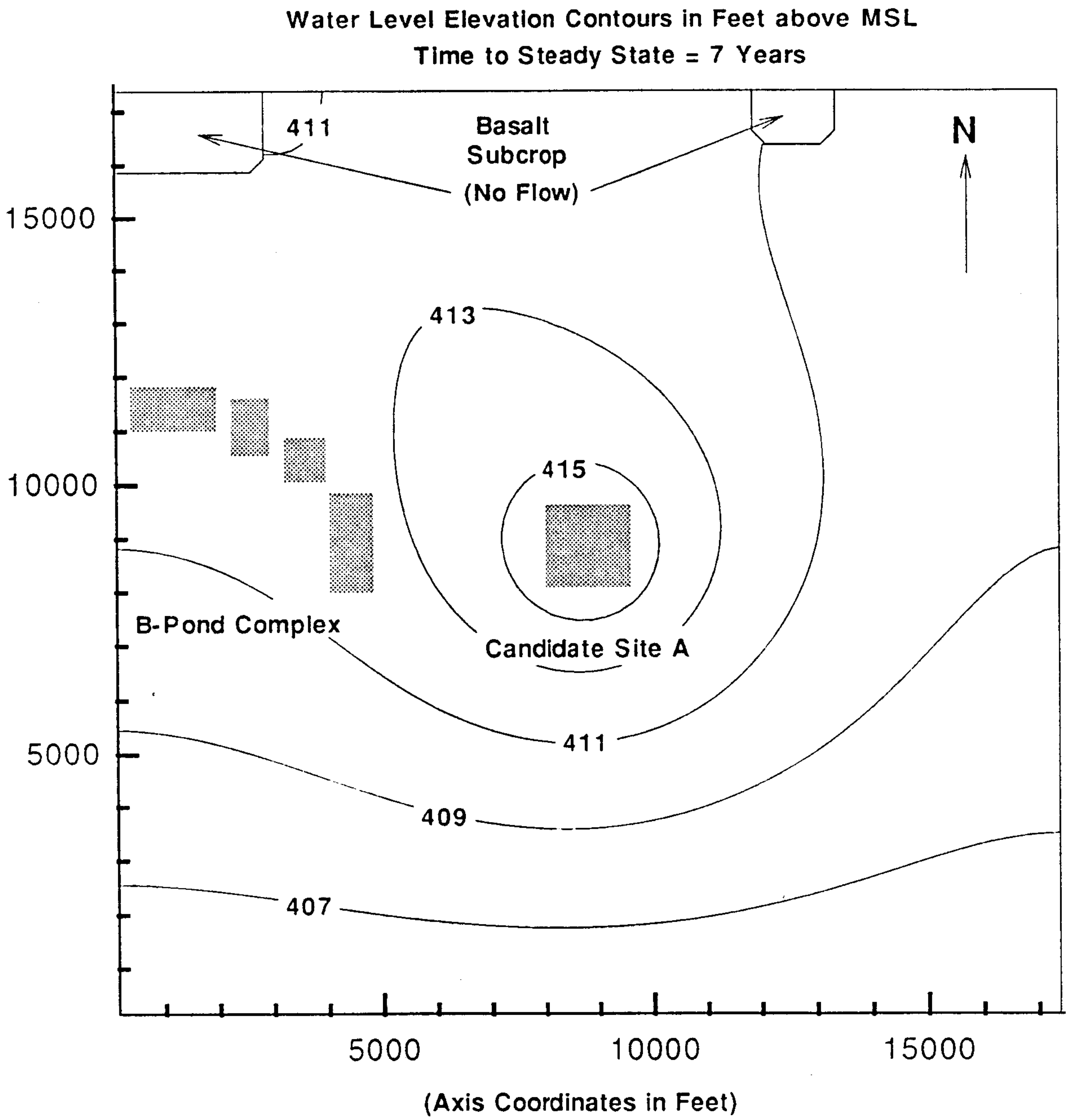

Figure A.3.6 Mounding of the Water Table Beneath Candidate Site "A" with a Discharge Rate of 1500 gpm and a Hydraulic Conductivity of 1000 ft/d.

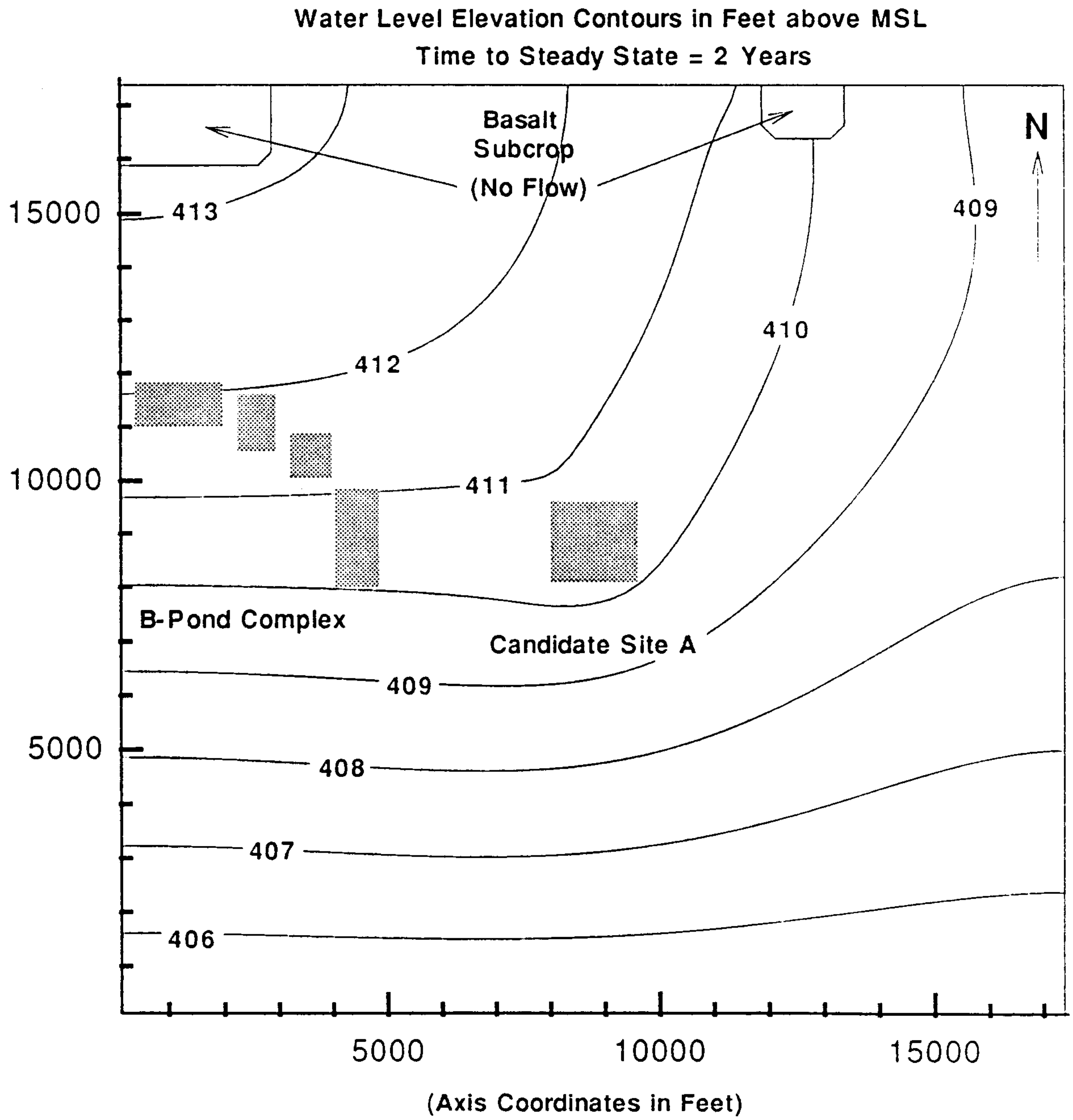

Figure A.3.7 Mounding of the Water Table Beneath Candidate Site "A" with a Discharge Rate of 1500 gpm and a Hydraulic Conductivity of 10,000 ft/d.

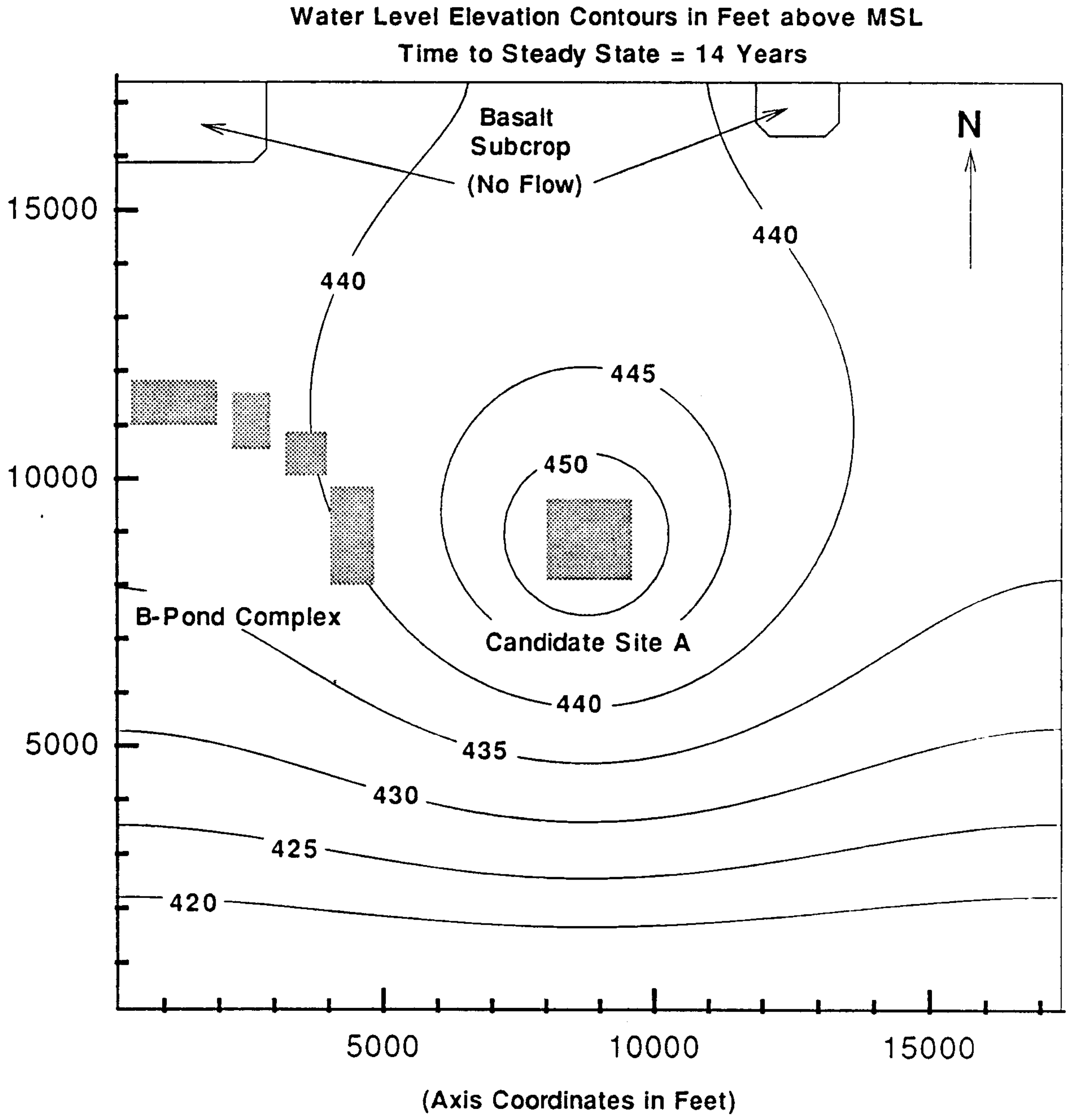

Figure A.3.8 Mounding of the Water Table Beneath Candidate Site "A" with a Discharge Rate of 15,000 gpm and a Hydraulic Conductivity of 1000 ft/d.

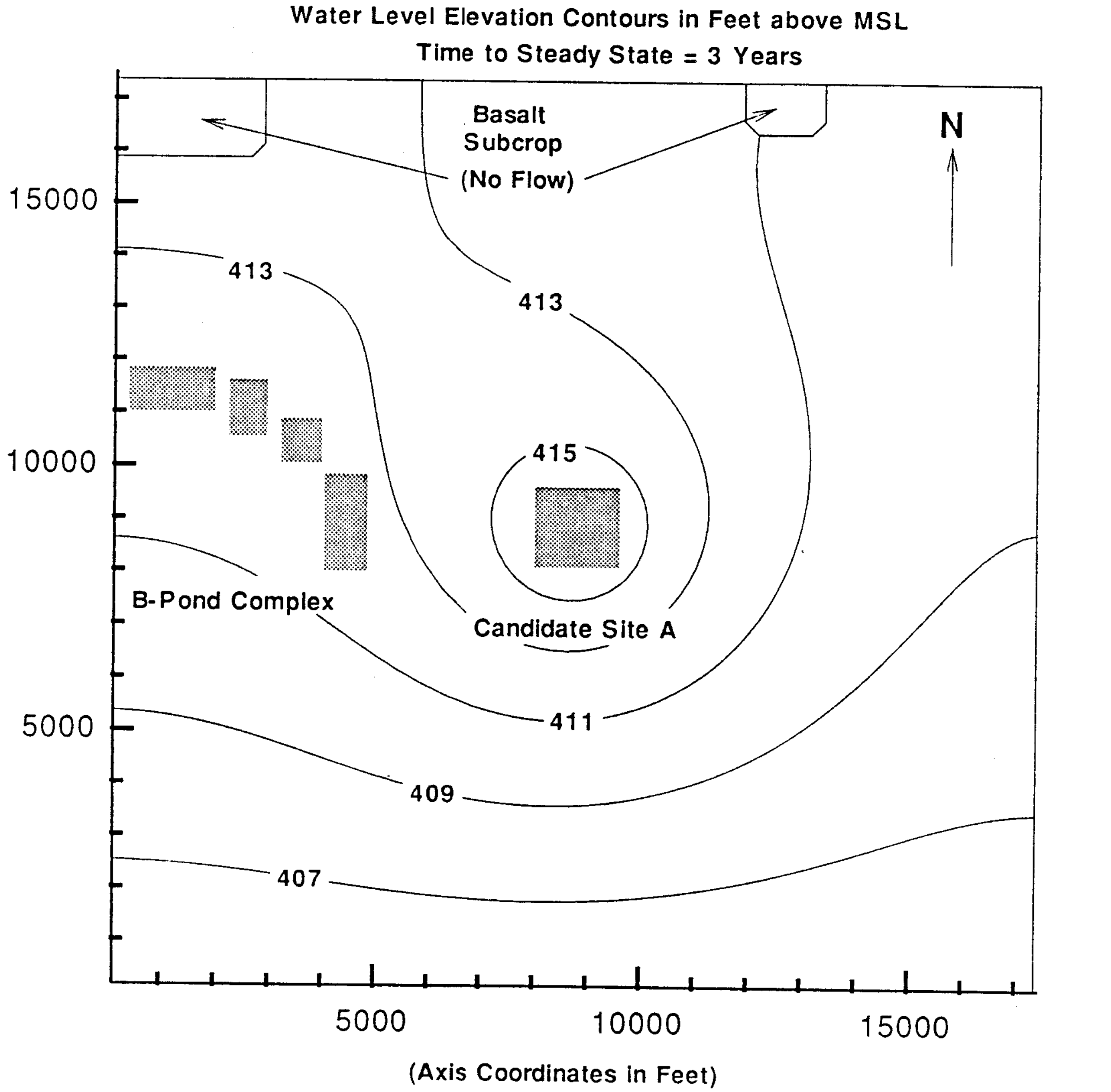

Figure A.3.9 Mounding of the Water Table Beneath Candidate Site "A" with a Discharge Rate of 15,000 gpm and a Hydraulic Conductivity of 10,000 ft/d.

9 2 1 2 3 5 3 1 5 5 0

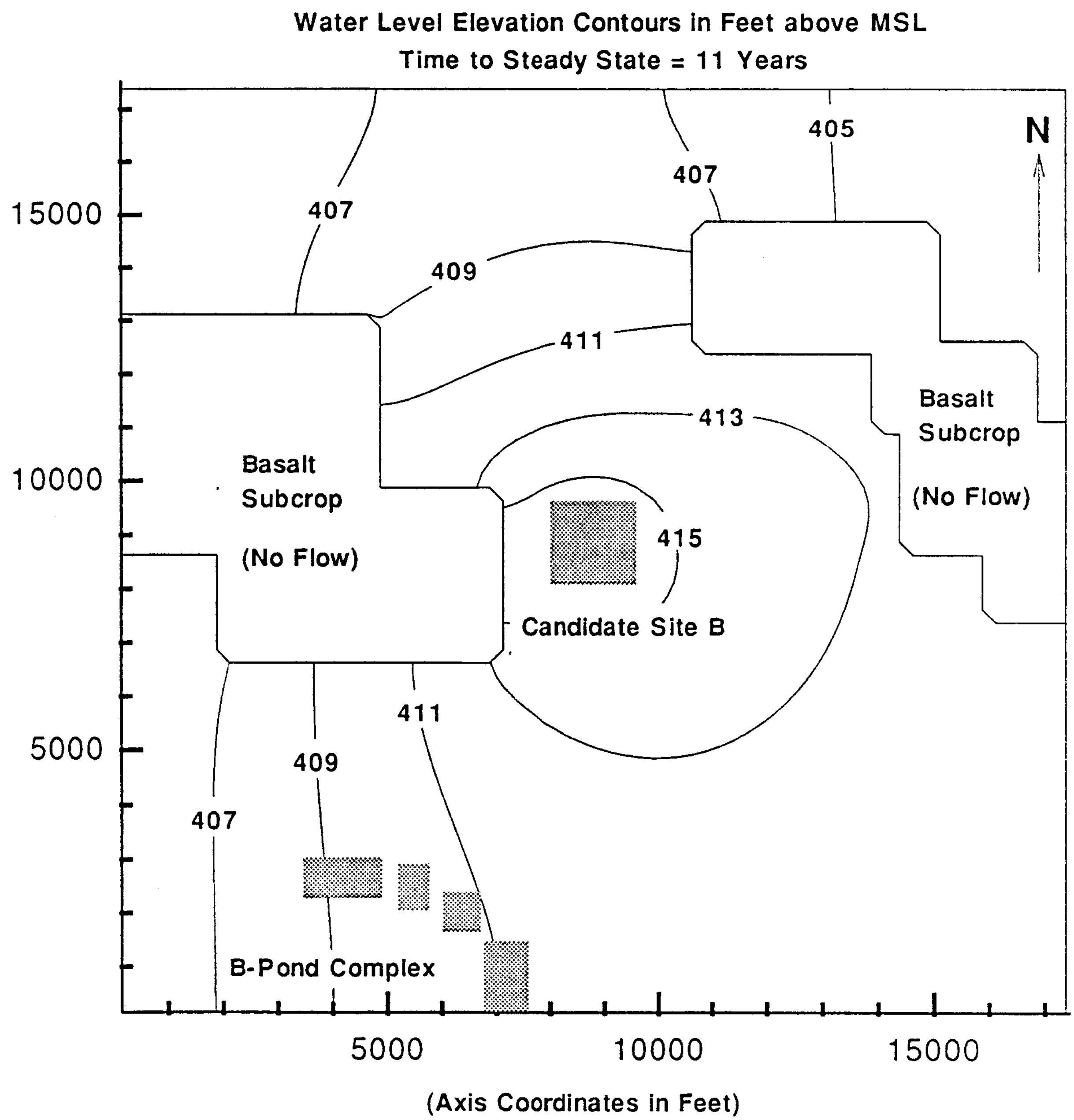

Figure A.3.10 Mounding of the Water Table Beneath Candidate Site "B" with a Discharge Rate of 1500 gpm and a Hydraulic Conductivity of 1000 ft/d.

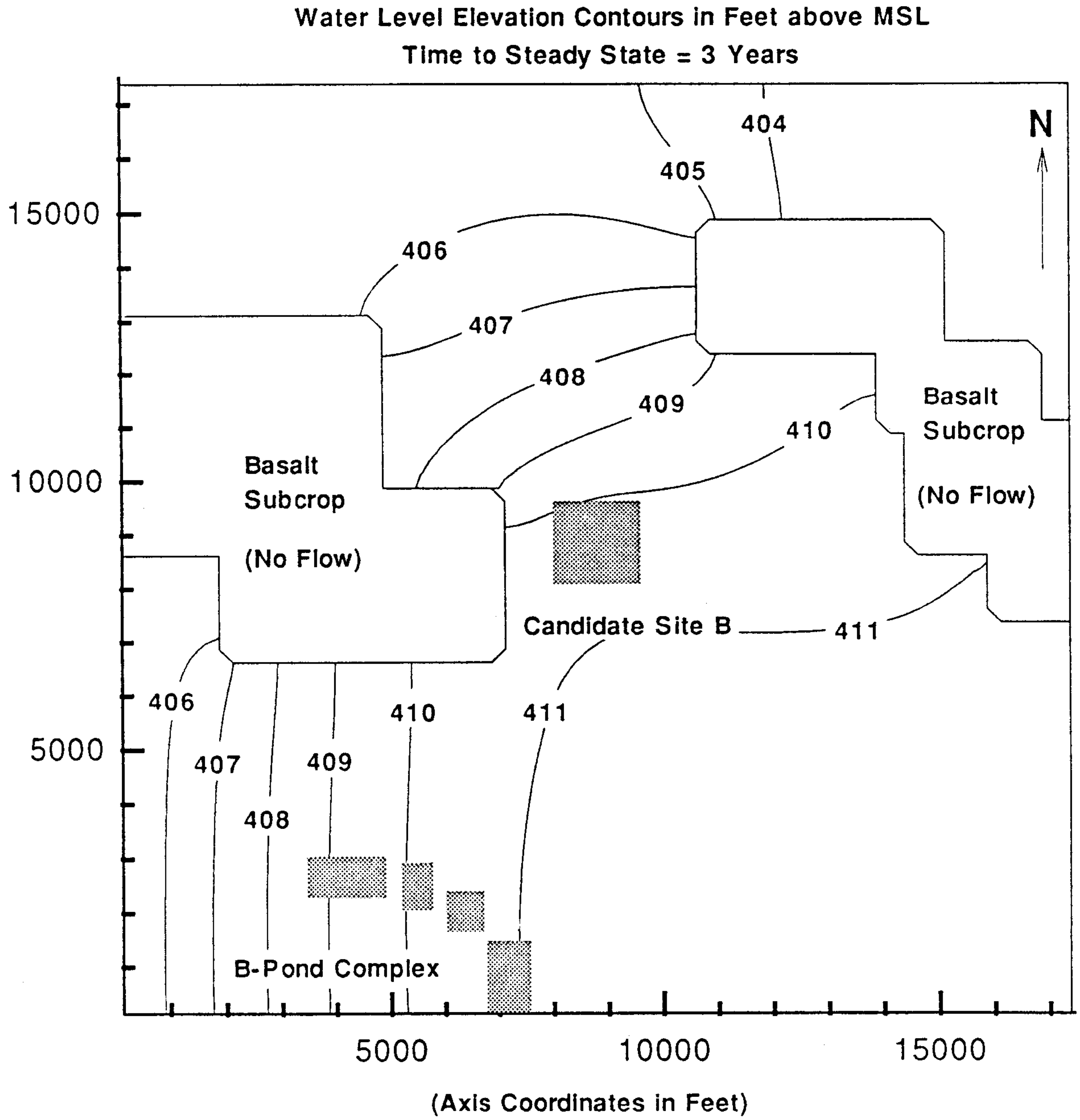

Figure A.3.11 Mounding of the Water Table Beneath Candidate Site "B" with a Discharge Rate of 1500 gpm and a Hydraulic Conductivity of 10,000 ft/d.

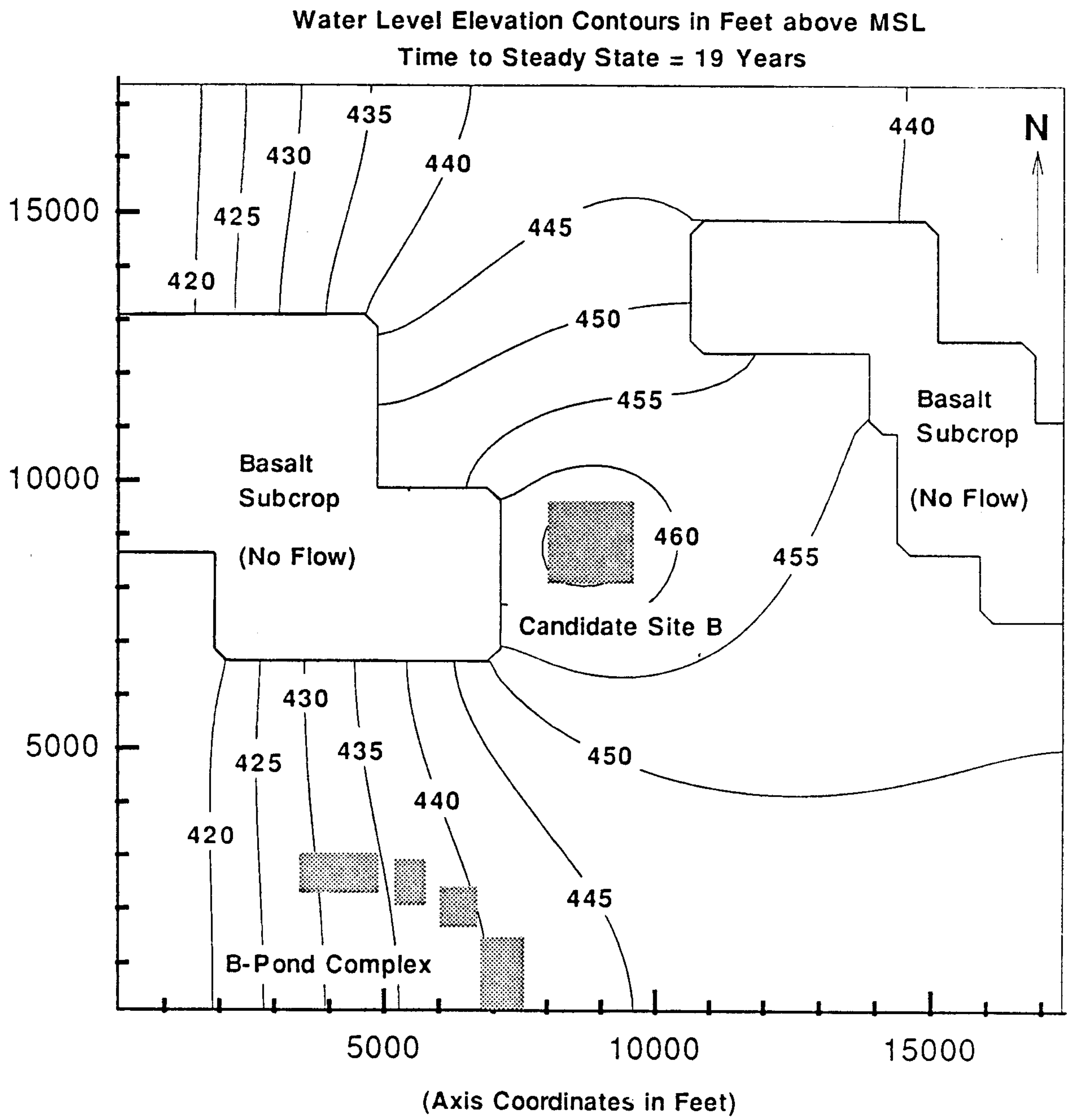

Figure A.3.12 Mounding of the Water Table Beneath Candidate Site "B" with a Discharge Rate of 15,000 gpm and a Hydraulic Conductivity of 1000 ft/d.

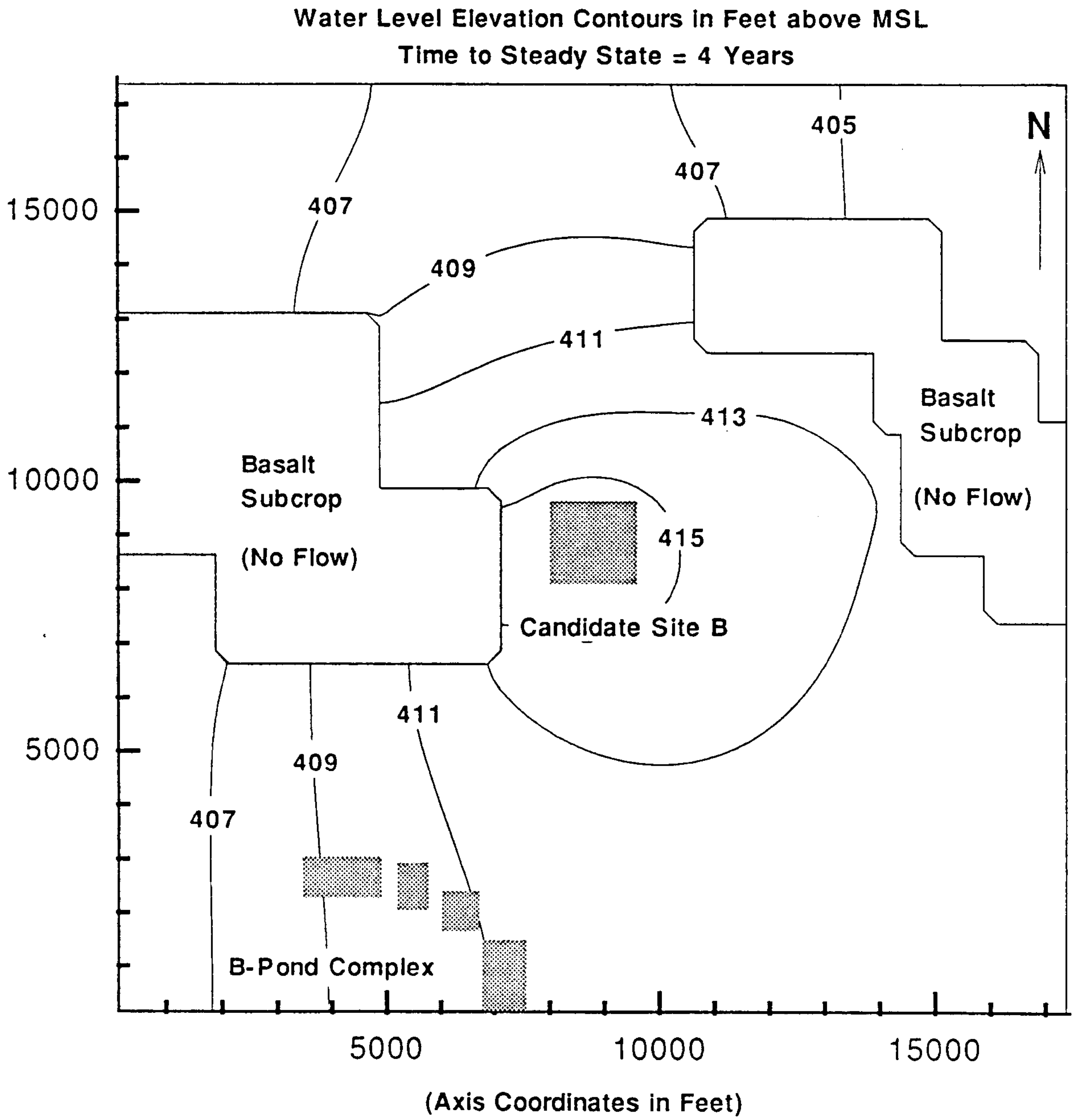

Figure A.3.13 Mounding of the Water Table Beneath Candidate Site "B" with a Discharge Rate of 15,000 gpm and a Hydraulic Conductivity of 10,000 ft/d.

steepest hydraulic gradient to the north. In this case, flow originating from the west would be deflected either north or south of the site to where the natural hydraulic gradient toward the Columbia River would eventually become the principal driving force.

Candidate Site "C". Site "C" is juxtaposed with the southern edge of the subcrop of shallow basalt north of the LERF. Consequently, that area of basalt and another area of shallow basalt to the west would effectively block development of water table mounding to the north and northwest. The western border of the grid was located in the same hydraulic plateau noted for site "B". The grid cells that defined that border were likewise assigned a constant-head status. The results of the simulations (Figures A.3.14 through A.3.17) suggest that the water table mound resulting from treated effluent disposal at site "C" would merge with the current mound resulting from effluent disposal at the B pond complex about 1.5 miles to the southeast.

Because of the resultant mound and the nearby basalt subcrops, flow from the west would be redirected to the south where the natural gradient toward the river would eventually redirect it to the east. Once the flow had migrated past the mound, the increased gradient caused by the mound would tend to accelerate the flow toward the Columbia River.

Candidate Site "D". The same two basalt subcrops that flank the east and west sides of candidate site "B" similarly flank the southeast and southwest sides of candidate site "D". The simulated domain extended into the area immediately north of the B pond complex. The northern portion of the water table mound resulting from operation of that facility affected the initial elevations of the water table as used in MODFLOW.

As was the case for candidate sites "B" and "C", the western border of the grid for site "D" was located in a hydraulic plateau. Consequently, the cells that defined that border were assigned constant-head status. The simulation results were similar to those for candidate site "B". The results (Figures A.3.18 through A.3.21) indicate that the water table mound at this site is elongated toward the southeast, with the steepest gradients to the north. The mound would inhibit flow to the east and deflect it either north or south of site "D" until the natural gradient toward the river is able to reexert itself.

A.3.f Conclusions

Because the MODFLOW results could not discriminate among the four candidate sites with respect to the respective sizes and shapes of the water table mounds predicted to result from the TEDB, the sites were evaluated according to their effects on the current ground water flow directions and contamination. Based on this criterion, the sites were ranked in the following order of decreasing preference for construction of the 200 Areas TEDB:

- Site "A"
- Sites "B" and "D"

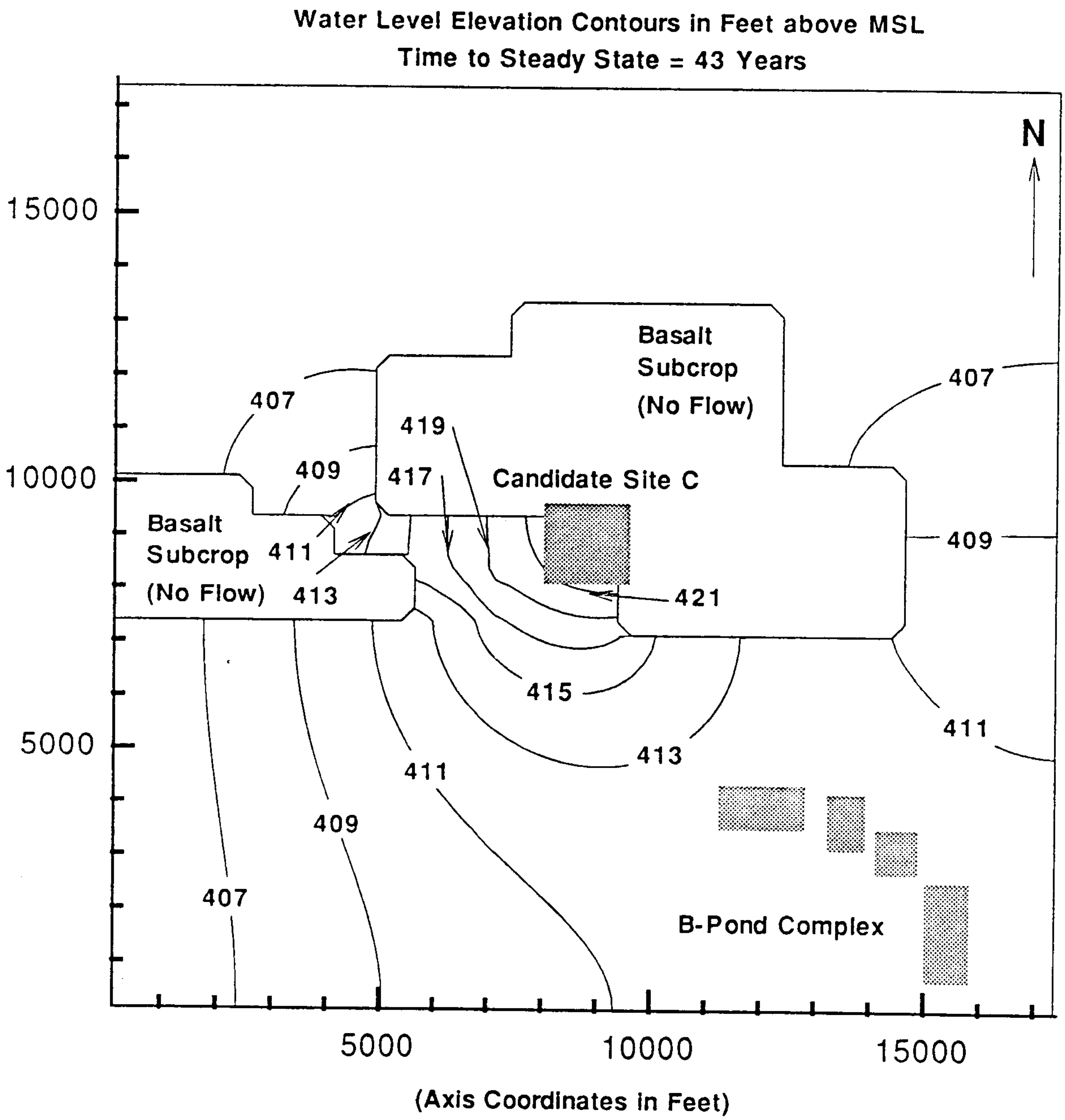

Figure A.3.14 Mounding of the Water Table Beneath Candidate Site "C" with a Discharge Rate of 1500 gpm and a Hydraulic Conductivity of 1000 ft/d.

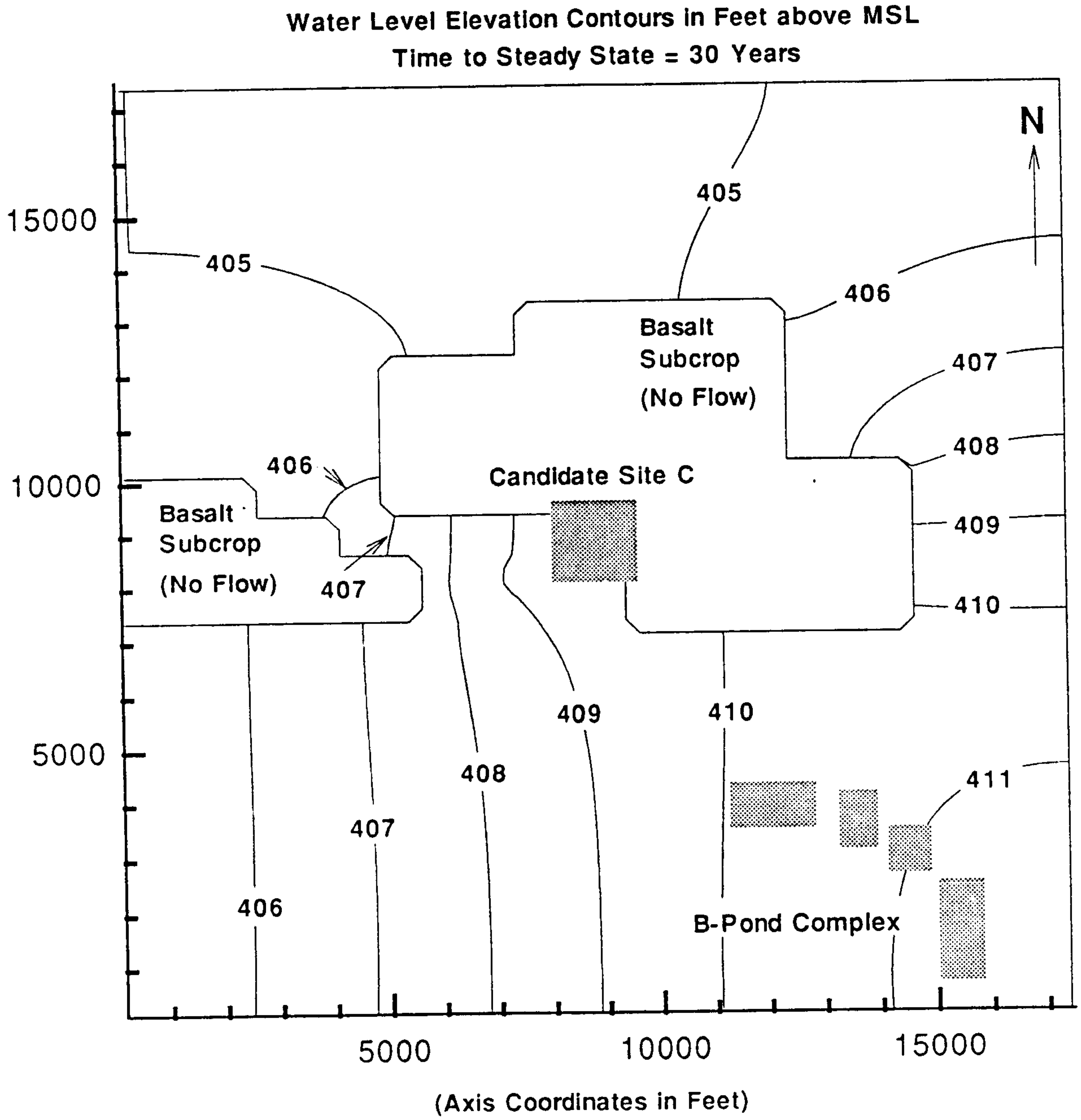

Figure A.3.15 Mounding of the Water Table Beneath Candidate Site "C" with a Discharge Rate of 1500 gpm and a Hydraulic Conductivity of 10,000 ft/d.

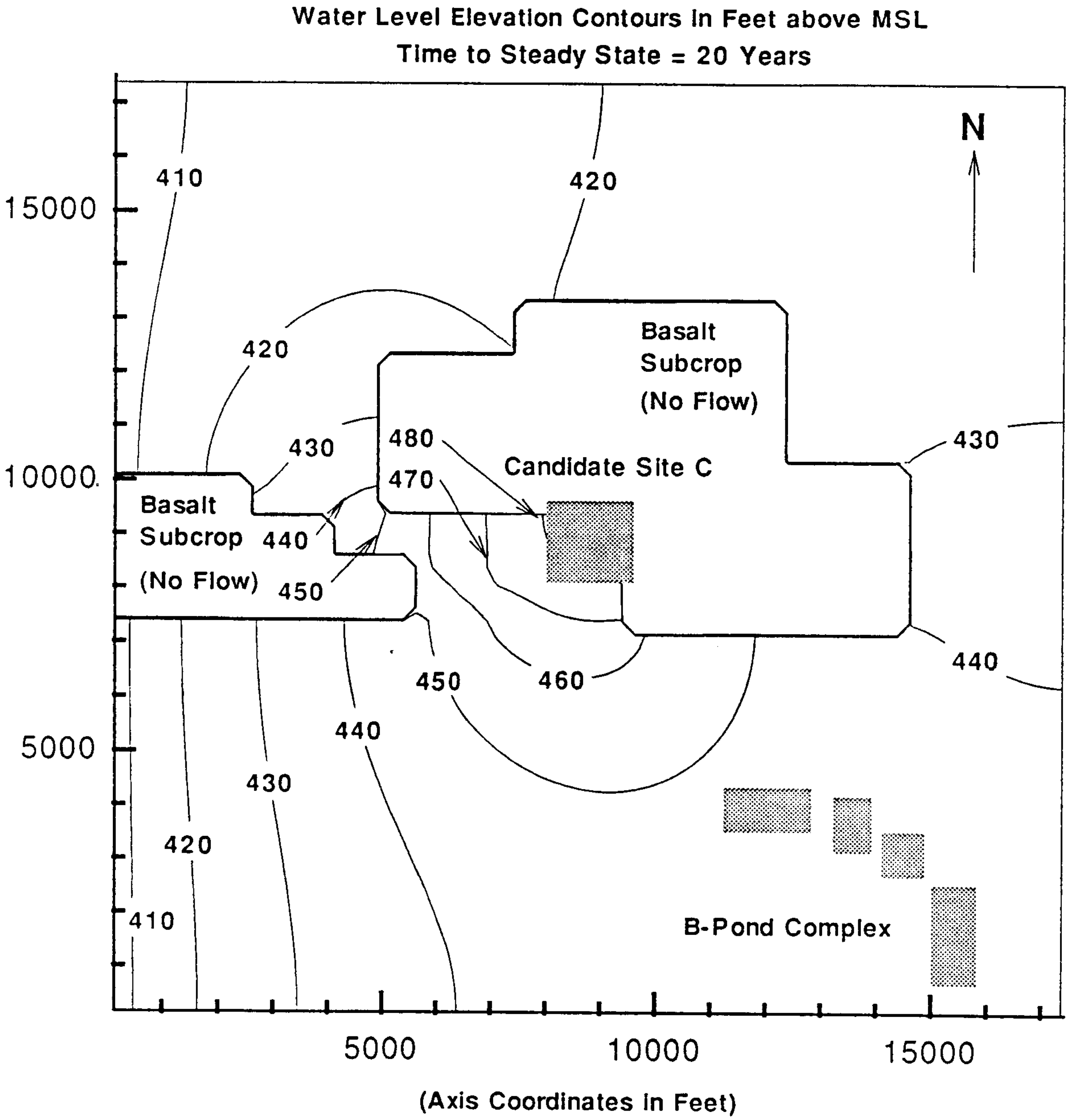

Figure A.3.16 Mounding of the Water Table Beneath Candidate Site "C" with a Discharge Rate of 15,000 gpm and a Hydraulic Conductivity of 1000 ft/d.

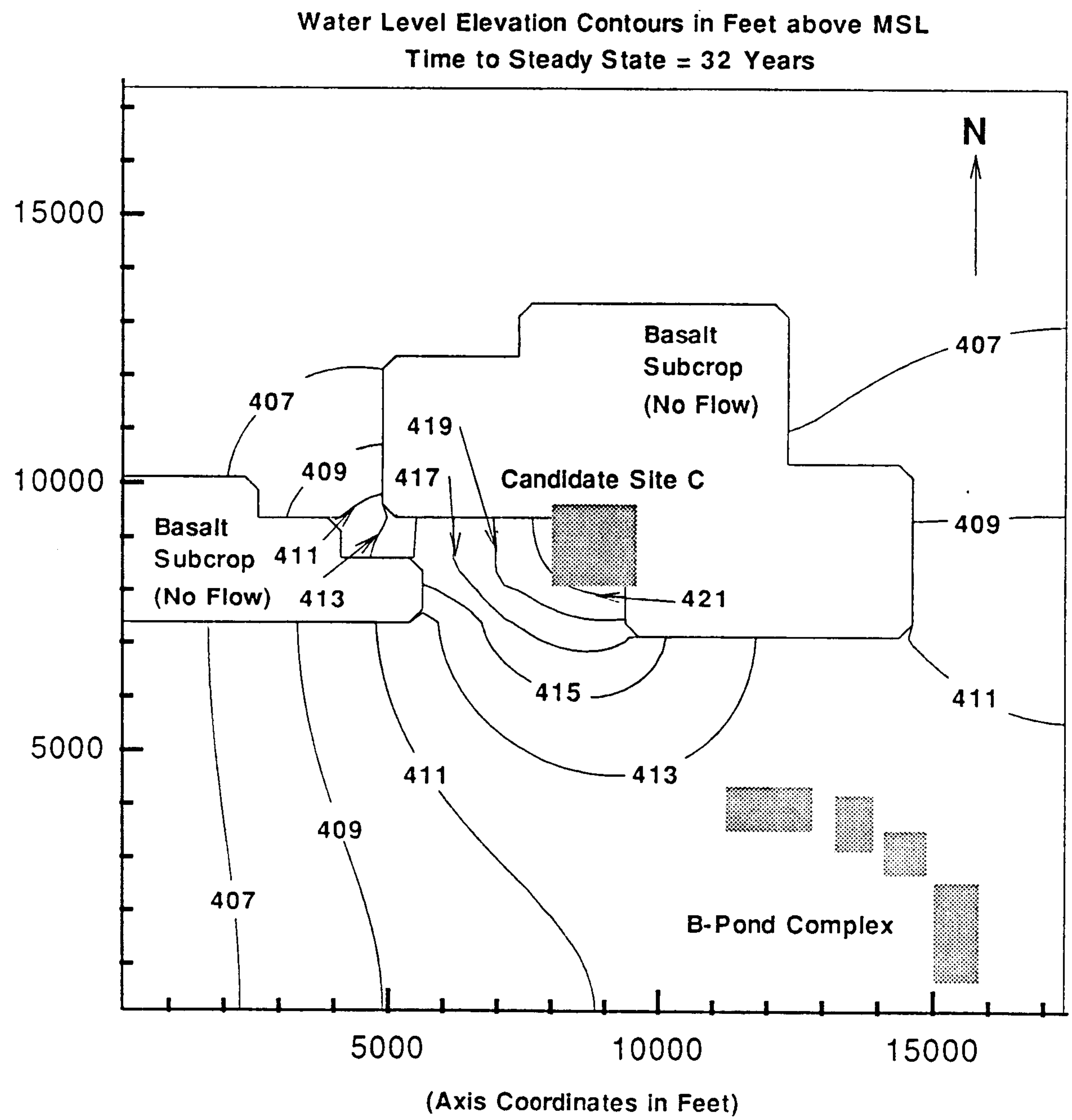

Figure A.3.17 Mounding of the Water Table Beneath Candidate Site "C" with a Discharge Rate of 15,000 gpm and a Hydraulic Conductivity of 10,000 ft/d.

Water Level Elevation Contours in Feet above MSL
Time to Steady State = 15 Years

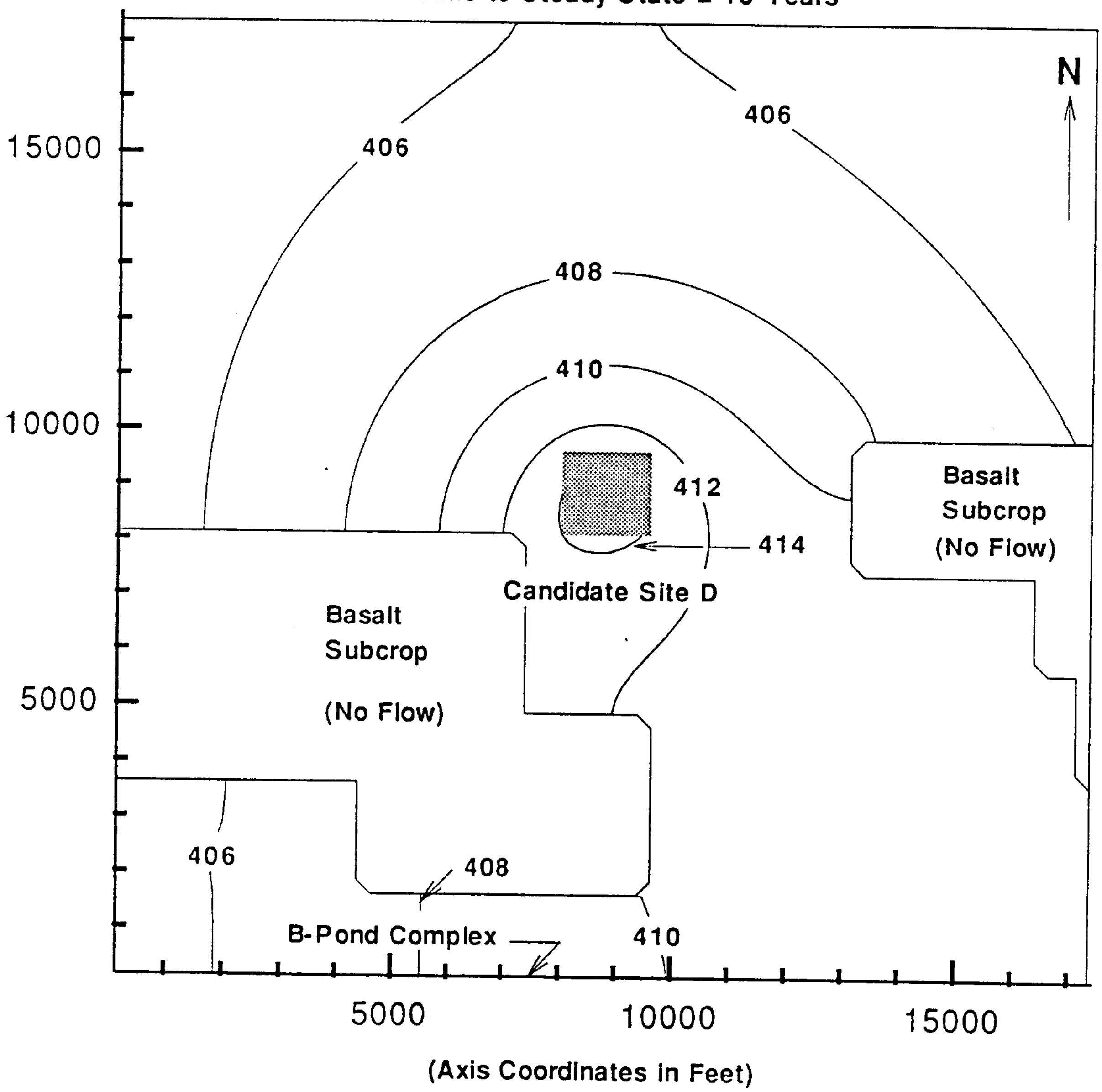

Figure A.3.18 Mounding of the Water Table Beneath Candidate Site "D" with a Discharge Rate of 1500 gpm and a Hydraulic Conductivity of 1000 ft/d.

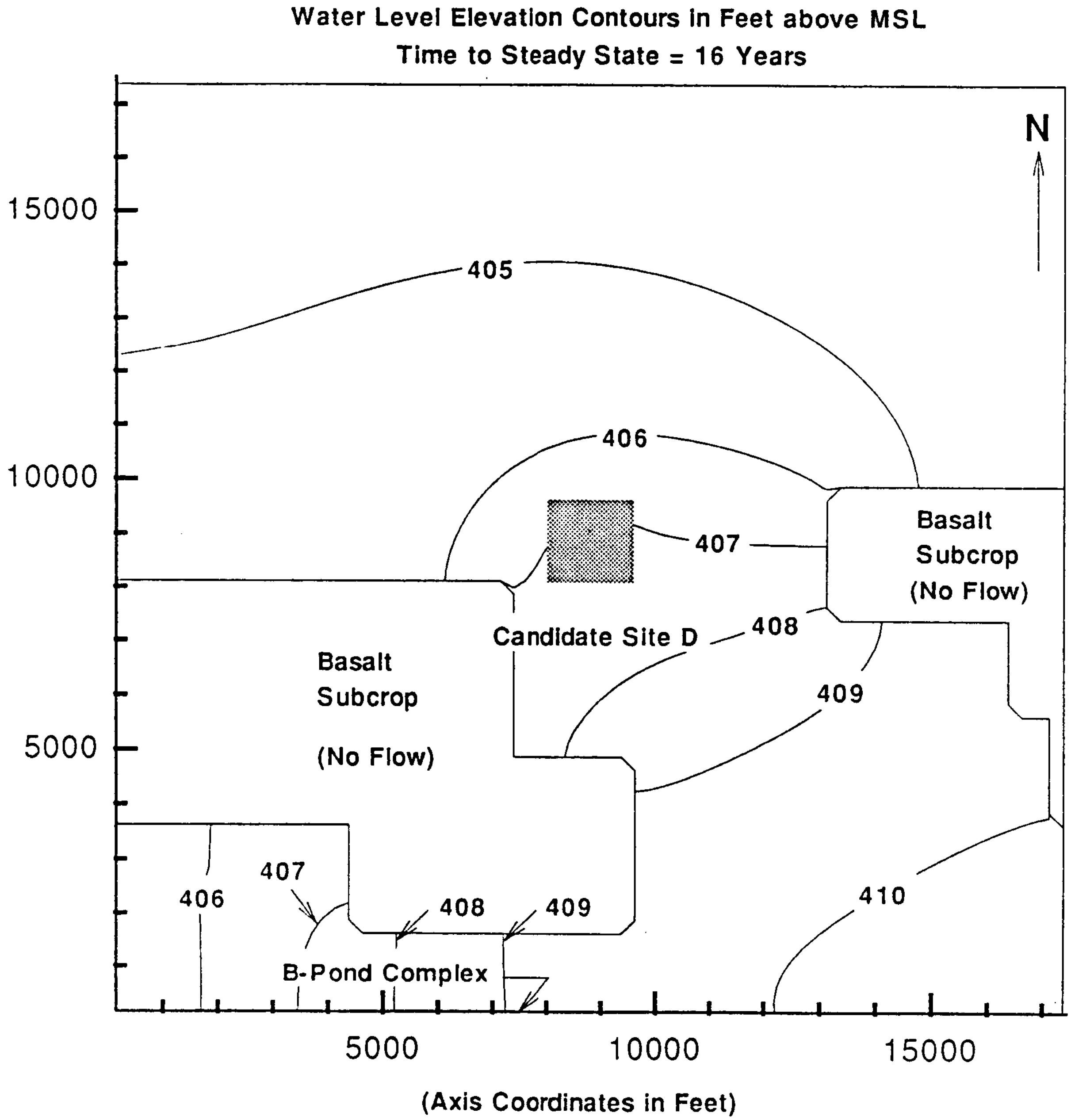

Figure A.3.19 Mounding of the Water Table Beneath Candidate Site "D" with a Discharge Rate of 1500 gpm and a Hydraulic Conductivity of 10,000 ft/d.

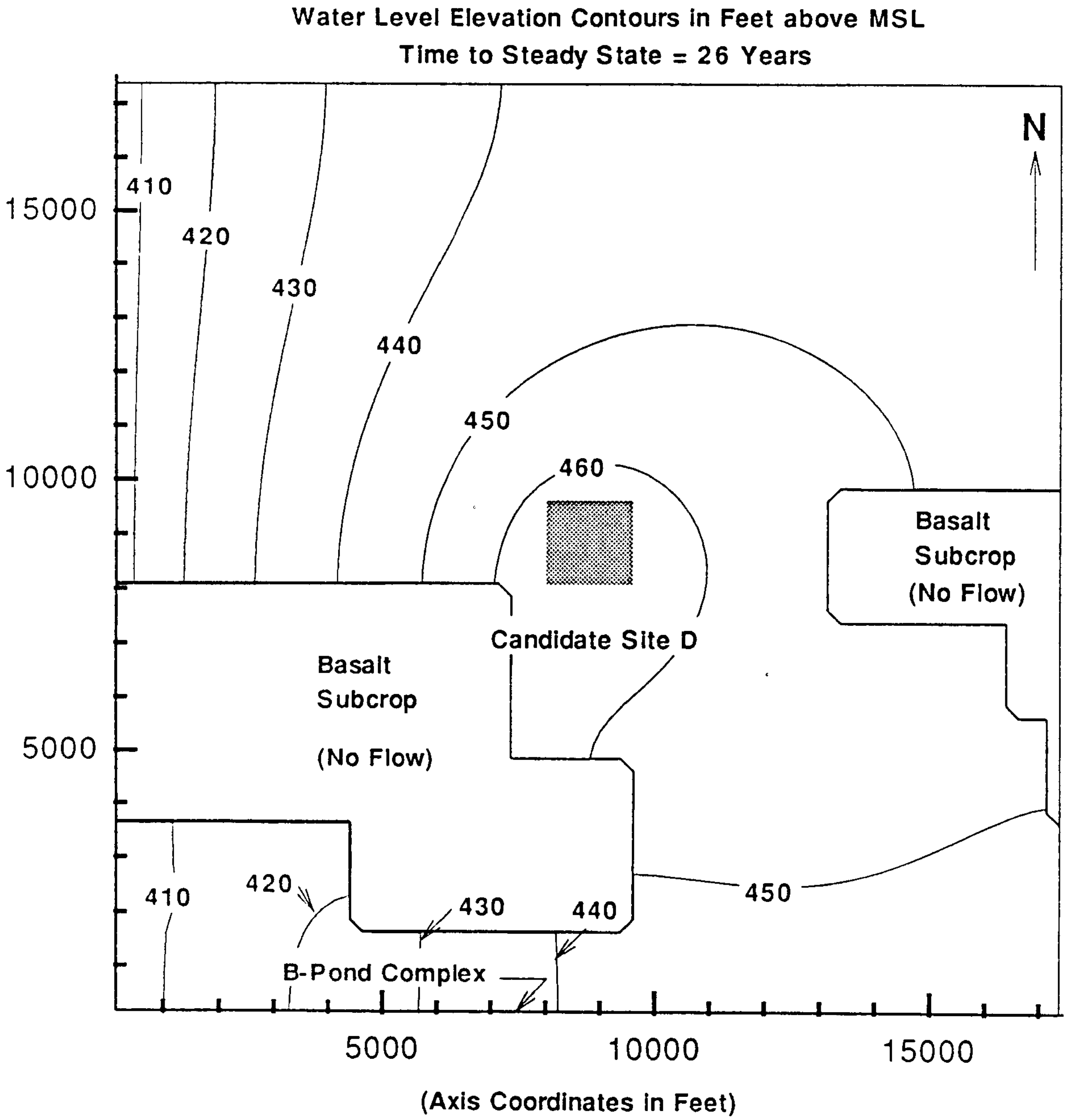

Figure A.3.20 Mounding of the Water Table Beneath Candidate Site "D" with a Discharge Rate of 15,000 gpm and a Hydraulic Conductivity of 1000 ft/d.

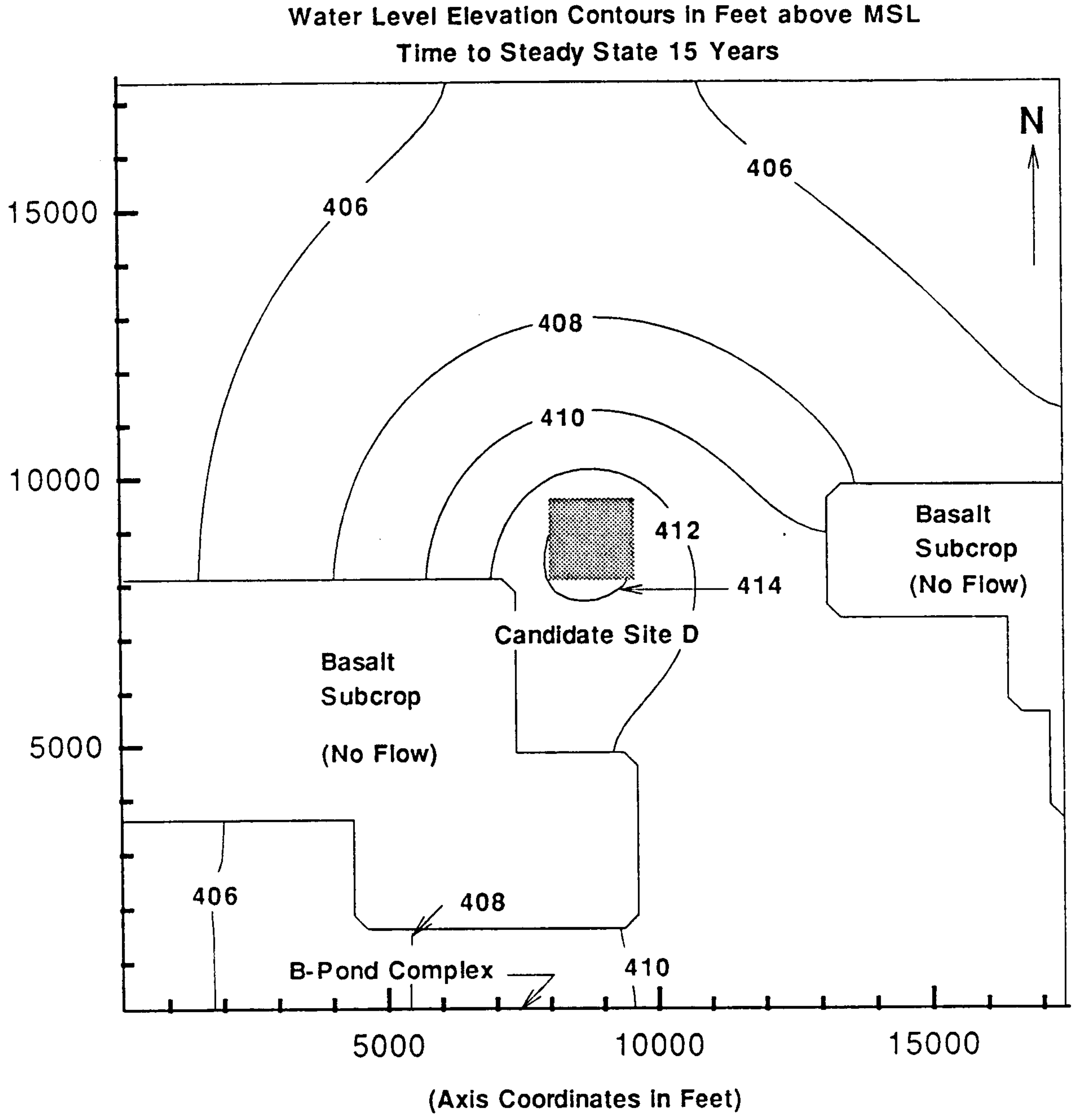

Figure A.3.21 Mounding of the Water Table Beneath Candidate Site "D" with a Discharge Rate of 15,000 gpm and a Hydraulic Conductivity of 10,000 ft/d.

- Site "C".

Site "A" was ranked highest because localized mounding of the water table at that site would decrease or reverse the current hydraulic gradient immediately to the west and, consequently, tend to form a hydraulic barrier or deflector to easterly, downgradient movement of contaminated ground water from the B pond complex to the Columbia River. Known contamination in the vicinity of site "A" is upgradient, to the west, and is associated with the B pond complex. This contamination of the unconfined aquifer includes nitrate concentrations of about 21,000 ppb (exceeds the WAC standard of 20,000 ppb) and tritium concentrations of about 95,000 pCi/L (exceeds the WAC standard of 45,000 pCi/L). Small amounts of TOC and TOX have also been detected in ground water monitoring wells north of the B lobe of B pond.

Development of a mound in the water table as a consequence of operating the 200 Areas TEDB at site "A" would create a hydraulic barrier or impediment between B pond and the Columbia River that would likely increase the current travel time to the river of nitrate and tritium from B pond. Because the hydrogeology of site "A" is similar to that of the B pond area, detailed characterization of site "A" is expected to make extensive use of relatively detailed monitoring and site investigation data from the vicinity of B pond.

Site "B" is about the same distance from B pond nitrate and tritium contamination as site "A", but lacks the hydrologic advantages of site "A". A localized elevation of the water table at this site would likely provide a hydraulic barrier to ground water moving north and northeast, toward the Columbia River, but would increase the hydraulic gradient in a southeasterly direction from B pond to the river. For this reason, site "B" is hydrologically less attractive than site "A".

Site "C" is much closer to known surface and subsurface contamination than the other candidate sites. Ground water contamination in this area includes technetium, cyanide, strontium, and nitrate. A mound in the water table at site "C" would likely adversely affect the direction and rate of movement of these contaminants and, additionally, could adversely affect the direction and rate of movement of tritium and nitrate from B pond. A change in the ground water flow direction beneath candidate area "C" that currently is controlled by the B pond mound would likely affect several RCRA facilities within and to the east of the 200 East Area. Installation of several new monitoring wells probably would be necessary to keep these facilities in compliance with provisions of the RCRA if the current flow directions were to change. A rise in the water table at site "C" could adversely affect the trench excavated for burial of naval submarine reactor compartments in the northeast corner of the 200 East Area.

Site "C" also partly overlies an area of basalt bedrock that is above the water table and is in proximity to the erosional window through the Elephant Mountain Basalt flow. Respectively, these factors would considerably complicate prediction of flow directions and increase the risk of hydrologic communication between the unconfined and uppermost confined aquifer. Hence, site "C" appears to be hydrologically the worst choice of the four candidates.

Site "D" is geologically more complex than sites "A" or "B". Development of a mound in the water table at this site may result in a hydraulic barrier to ground water movement to the northeast; however, prediction of the effects on flow gradients and flow paths is difficult because the local slopes of the basalt bedrock above the water table are not well known. In addition, the proximity of this site to potential contamination associated with the former location of Gable Mountain Pond may increase its risk.

APPENDIX B

Cultural Resources Review

The attached letters report the results of a cultural resources review of candidate areas for the Project W-049H TEDB. The review of previous surveys in the area of interest was made in applying screening criterion 3.3, *Negative Effect on Cultural Resources.* The map referred to by the 11 April 1991 letter is Figure 8 of this report. The information on hand-drawn, rough-draft maps enclosed with the letters was incorporated into Figure 9 of this report as "parcels surveyed by the Hanford Cultural Resources Laboratory (HCRL)" and "parcels surveyed at an unacceptable level of intensity". That part of the highest-ranked site which previously was unsurveyed required a detailed, ground-based survey by the HCRL. The results of that survey, completed in August 1991, are reported in the 21 August 1991 letter at the end of this appendix.

Battelle
Pacific Northwest Laboratories
Battelle Boulevard
P.O. Box 999
Richland, Washington 99352
Telephone (509) 376-8010

11 April 1991

Survey Required

Dr. Kenneth L. Petersen, H4-14
Environmental Programs
Westinghouse Hanford Company
Richland, WA 99352

RE: CULTURAL RESOURCES REVIEW OF THE 200A TEDB, FRESH WATER POND FACILITY.
HCRC #91-600-009

Ref. #1. Rice, D. G. 1968. *Archaeological Reccnnaissance of the Hanford Atomic Works.* Washington State University Laboratory of Anthropology, Pullman, WA.

Dear Dr. Petersen,

In response to your request received 9 April 1991, staff of the Hanford Cultural Resources Laboratory (HCRL) conducted a cultural resources review of the subject project, located in the 600 area of the Hanford site. According to information supplied by you, the project entails development of a 5 to 50 acre pond to the northeast of the 200 East area as outlined on the map you provided.

Our literature and records review showed that several parcels within the project area have been previously surveyed for cultural resources. These parcels are marked and dated on the enclosed map and no cultural properties have been identified within the surveyed areas. One surveyed parcel, labeled AEC 1968 (ref. 1), was surveyed at an unacceptable level of intensity, and if this area should be selected for development further ground reconnaissance will be necessary. Of course, if a site for the 200A TEDB is chosen in an area not previously surveyed for cultural resources, ground reconnaissance will be required before the project can proceed in that area.

It is the finding of the Hanford Cultural Resources Laboratory (HCRL) staff that there are no cultural or historic properties in the previously surveyed portions of the project area with the exception of the parcel labeled AEC 1968. Survey or monitoring of excavations within those areas by an archaeologist is not required. The workers, however, should be directed to watch for cultural materials (e.g., bones, artifacts) during excavations. If any are encountered, work in the vicinity of the discovery must stop until an HCRL archaeologist has been notified, has assessed the

K. L. Petersen
11 April 1991
Page 2

Battelle

significance of the find, and, if necessary, has arranged for mitigation of the impacts to the find. This is a class V case, a project involving undisturbed ground.

This letter constitutes cultural resource clearance for your project for those parcels previously surveyed. A copy of this has been sent to Kevin Clarke of DOE-RL as official documentation of clearance. If you have any questions I can be reached at 376-8010. Please utilize the HCRC# for any future correspondence concerning this project.

Sincerely,

Hal Gard

Hal Gard
Scientist
Cultural Resource Project

Concurrence:

J. C. Chatters, Ph.D., Manager
Cultural Resource Project

cc: K. V. Clarke, DOE-RL (2)

Attachment

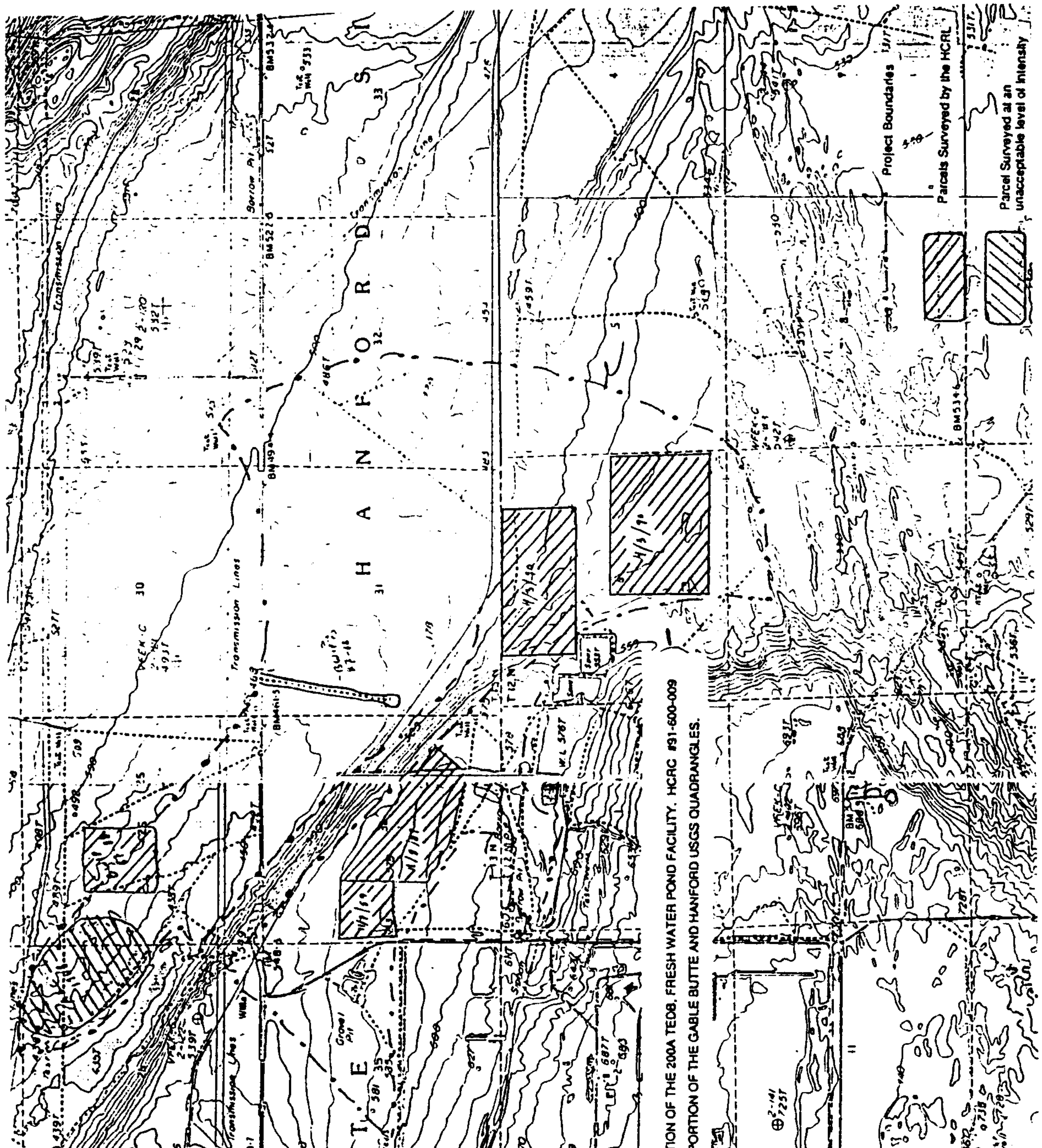

Figure B.1 Parcels Previously Surveyed in the Area of Interest for Cultural Resources.

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Richland, Washington 99352
Telephone (509) 376-8010

2 May 1991

Survey Required

Dr. Kenneth L. Petersen, H4-14
Environmental Programs
Westinghouse Hanford Company
Richland, WA 99352

RE: CULTURAL RESOURCES REVIEW OF THE 200A TEDB, FRESH WATER POND FACILITY. HCRC #91-600-009 AMENDED.

Dear Ken,

Enclosed is the additional information you requested pertaining to cultural resource surveys conducted within the area outlined on the map you sent to me on 9 April 1991. No large coverage surveys were preformed within this area. The only cultural resource surveys conducted were isolated drilling pad inspections which are depicted on the attached map. One historic archaeological site was recorded and is designated as HT-88-007. Field notes taken at the time suggest that this site is insignificant, however, I tend to view historic sites a little more carefully than my predecessor. Therefore, I would rather provide an opinion after I have had an opportunity to evaluate the site myself.

This letter will amend the cultural resource clearance letter to you dated 11 April 1991. Sorry about taking so long to get back to you.

Regards,

Hal Gard
Scientist
Cultural Resource Project

Attachment

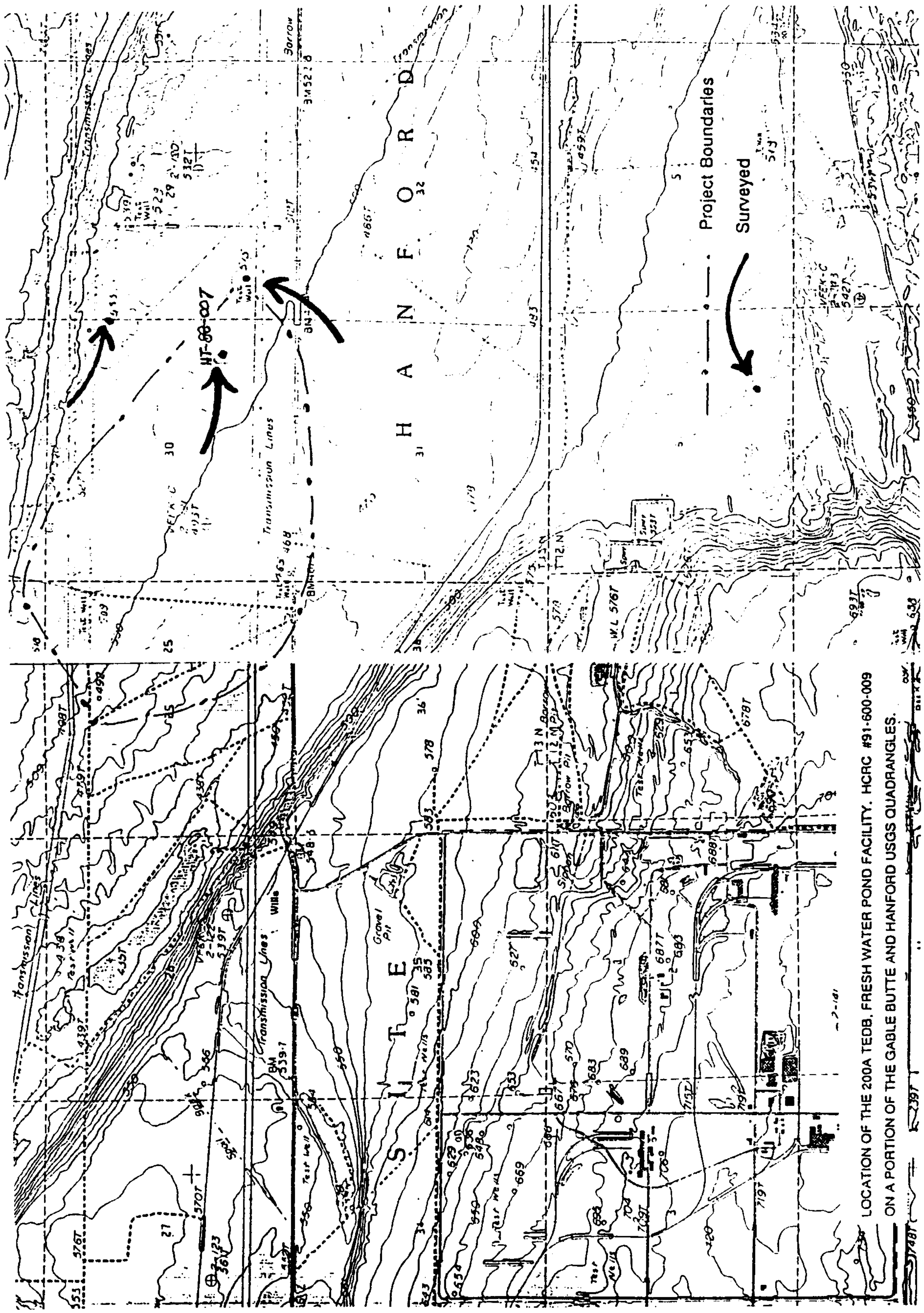

Figure B.2 Inspections of Drilling Pads in the Area of Interest for Cultural Resources.

9104119

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21 August 1991

Dr. Kenneth L. Petersen, H4-14
Environmental Programs
Westinghouse Hanford Company
Richland, WA 99352

RE: CULTURAL RESOURCES SURVEY OF THE 200A TEDB, FRESH WATER POND FACILITY.
HCRC #91-600-009

Dear Dr. Petersen,

On 20 August 1991, Hanford Cultural Resources Laboratory (HCRL) preformed a cultural resources survey of the proposed location of the 200 A Treated Effluent Disposal Basin located in the 600 area of the Hanford Site.

A 750 m north/south by 200 m east/west area in Section 5, T12N, R27E (Hanford Quad.), was surveyed in 20 m spaced north/south transects. Surface visibility ranged from 30% to 70% and averaged 50%. No cultural resources were located within this area. Furthermore, geomorphological indicators and previous experience indicates that the chances of encountering buried cultural material within this area are considered to be low.

It is the finding of the HCRL staff that there are no known cultural or historic properties within the project area. If any cultural remains are encountered during the course of the project, however, work in the vicinity of the discovery must stop until an HCRL archaeologist has assessed the significance of the find, and, if necessary, has arranged for mitigation of the impacts to the find. Monitoring of excavations by an archaeologist is not required. This is a Class V case, Projects involving undisturbed ground. Please notify this office if any changes to the project location or dimensions are anticipated.

This letter constitutes cultural resource clearance for your project. A copy of this has been sent to Charles Pasternak, DOE-RL as official documentation of clearance. If you have any questions I can be reached at 376-8010. Please utilize the HCRL# for any future correspondence concerning this project.

Sincerely,

Hal Gard

Hal Gard
Scientist
Cultural Resource Project

cc: Charles Pasternak, DOE-RL(2)

APPENDIX C

-- D. S. Landeen and M. R. Sackschewsky --

Survey for Threatened or Endangered Species

The attached letter reports the results of a plant- and animal-life survey of candidate areas for the Project W-049H TEDB. The survey was made in applying screening criterion 3.4, *Negative Effect on Threatened or Endangered Species*. The highest-ranked site will be resurveyed in greater detail in the spring of 1992, the time of year during which the maximum number of species are known to be present and active in the area of interest. The results of that survey will be issued as a supplement to this appendix.

C.1 ANIMAL SURVEYS

Bird and mammal surveys were conducted in all candidate areas (A, B, C, and D); however, more attention was given to Candidate Area "A" because of its proximity to existing effluent disposal facilities (i.e., B-pond). No state or federal threatened or endangered species were observed during the course of these investigations. All birds observed are listed below. Because much of this area consists of undisturbed sagebrush habitat, there are a few bird species, like sage sparrows and loggerhead shrikes, who utilize these areas for nesting. Single long-billed curlews were observed on three occasions. Burrowing owls were not observed during the surveys, but they probably occur in the area. Mammals that were observed or noted to be inhabiting these sites were pocket mice, coyotes, badgers, jackrabbits, and mule deer. Only one fawn was observed near "C" lobe of B-pond during the course of these investigations.

<u>Bird Species Observed</u>

Red-tailed Hawk
Killdeer
California Gull
Common Nighthawk
Western Kingbird
Horned Lark
Cliff Swallow
Loggerhead Shrike*
Sage Sparrow*
Long-billed Curlew*
Western Meadowlark
White-crowned Sparrow
European Starling
Black-billed Magpie
Common Raven
Rock Dove

The three species with asterisks are designated as Species of Special Concern (SC) by the State of Washington. Burrowing owls are also listed under this category. Species with this designation are currently being reviewed for possible status changes. At this time, species designated as SC are afforded no legal protection by the State of Washington. However, the construction of a liquid effluent disposal facility is not anticipated to be significantly adverse to these species.

C.2 PLANT SURVEYS

Selected areas within a two-mile radius of the LERF facility were surveyed for the presence of plants considered endangered, threatened, or sensitive by the Washington Natural Heritage Program. A list of those species of concern that have been reported on or near the Hanford Site is provided in Table C-1. Because of the large area under consideration for the siting of the 200 Areas TEDB, only selected areas could be thoroughly examined. The locations of these areas are shown on Figure C-1. These areas were selected to encompass as wide a range of habitat types as possible, and to provide a relatively even distribution of sampling sites. The area on Figure C-1 marked "1990" was previously surveyed in the spring of 1990 for another project; at that time, no species of concern were identified within that area.

The surveys were conducted by walking the selected area while identifying and listing each different plant species as it was encountered. Species identified in each candidate area are given in Tables C-2 through C-5. Documentation specimens were collected for several species to aid in identification. These specimens have been pressed and are currently available for examination in Room 14A, 345 Hills Street, Richland, WA. These specimens will eventually be located at the Hanford Meteorological Station.

Different species become identifiable at different times during the growing season; these surveys were conducted over a period of about 6 weeks. Therefore, some species that were found in one location are probably present in the other locations, but the surveys in the other sites were conducted either too early or too late for proper identification. The time during which these surveys were made (late April through early June) corresponds to the season that most plant species on the Hanford Site are in an identifiable stage in their life cycles.

No endangered, threatened, or sensitive plant species were encountered in any of the candidate areas. One species, Piper's Daisy, was discovered in proximity to Candidate Area "A". This is the first reported finding of this species in the vicinity of the 200 Areas. A sparse population of approximately 20 individuals was found on the man-made berm created with the material excavated from the C-lobe of B-pond. This is just west of Candidate Area "A".

Piper's Daisy is listed as "sensitive" by the Washington Natural Heritage Program, meaning that the species is declining in the State of Washington, or that its habitat is vulnerable without active management or protection. There are no legal obligations or statutes that regulate species in this category. However, the Washington Natural Heritage Program recommends that efforts be made to prevent disturbance to populations of species listed as sensitive. The population found during this survey is unusual in that this species is normally not known to colonize highly disturbed ground. The siting of the 200 Areas TEDB should not have any serious impacts on this population because no individuals were found in the candidate areas. However, piping and service roads should be located to minimize the impact on this population.

Recommendation

Selection of a specific site for construction of the 200 Areas TEDB can proceed anywhere within a 2-mile radius of the LERF that meets slope, areal extent, and ground water protection criteria. No endangered, threatened, or sensitive plant species will be affected by construction of the TEDB in this area (with the exception of Piper's Daisy, as discussed previously). When a specific site is identified, an intensive follow-up survey should be conducted at this site, as well as along the projected lines of associated piping and access roads.

TABLE C.1 Threatened, Endangered, or Sensitive Plant Species that Occur on or Adjacent to the Hanford Site.*

Scientific Name	Common Name	Family	Washington State Status
*Rorippa columbiae*** Suksd. ex Howell	Persistantsepal Yellowcress	Brassicaceae	Endangered
Artemesia campestris L ssp. *borealis* (Pall.) Hall & Clem. var. *wormskioldii*** (Bess.) Cronq.	Northern Wormwood	Asteraceae	Endangered
*Astragulus columbianus*** Barneby	Columbia milk-vetch	Fabaceae	Threatened
*Lomatium tuberosum*** Hoover	Hoover's Desert-Parsley	Apiaceae	Threatened
Astragalus arrectus Gray	Palouse Milk-vetch	Fabaceae	Sensitive
Collinsia sparsiflora Fisch.&Mey. var *bruciae* (Jones) Newsom	Few-Flowered Collinsia	Scrophulariaceae	Sensitive
Cryptantha interrupta (Greene)Pays.	Bristly Cryptantha	Boraginaceae	Sensitive
Cryptantha leucophea Dougl. Pays	Gray Cryptantha	Boraginaceae	Sensitive
Erigeron piperianus Cronq.	Piper's Daisy	Asteraceae	Sensitive
Carex densa L.H. Bailey	Dense Sedge	Cyperaceae	Sensitive
Cyperus rivularis Kunth	Shining Flatsedge	Cyperaceae	Sensitive
Limosella acaulis Ses.&Moc.	Southern Mudwort	Scrophulariaceae	Sensitive
Lindernia anagallidea (Michx.)Pennell	False-pimpernel	Scrophulariaceae	Sensitive
Nicotiana attenuata Torr.	Coyote Tobacco	Solanaceae	Sensitive
Oenothera pygmaea Dougl.	Dwarf Evening-Primrose	Onagraceae	Sensitive

* All of these species have been reported on or near the Hanford Site. Level and quality of documentation varies from species to species.

** Indicates candidates on the 1985 Federal Register, Notice of Review.

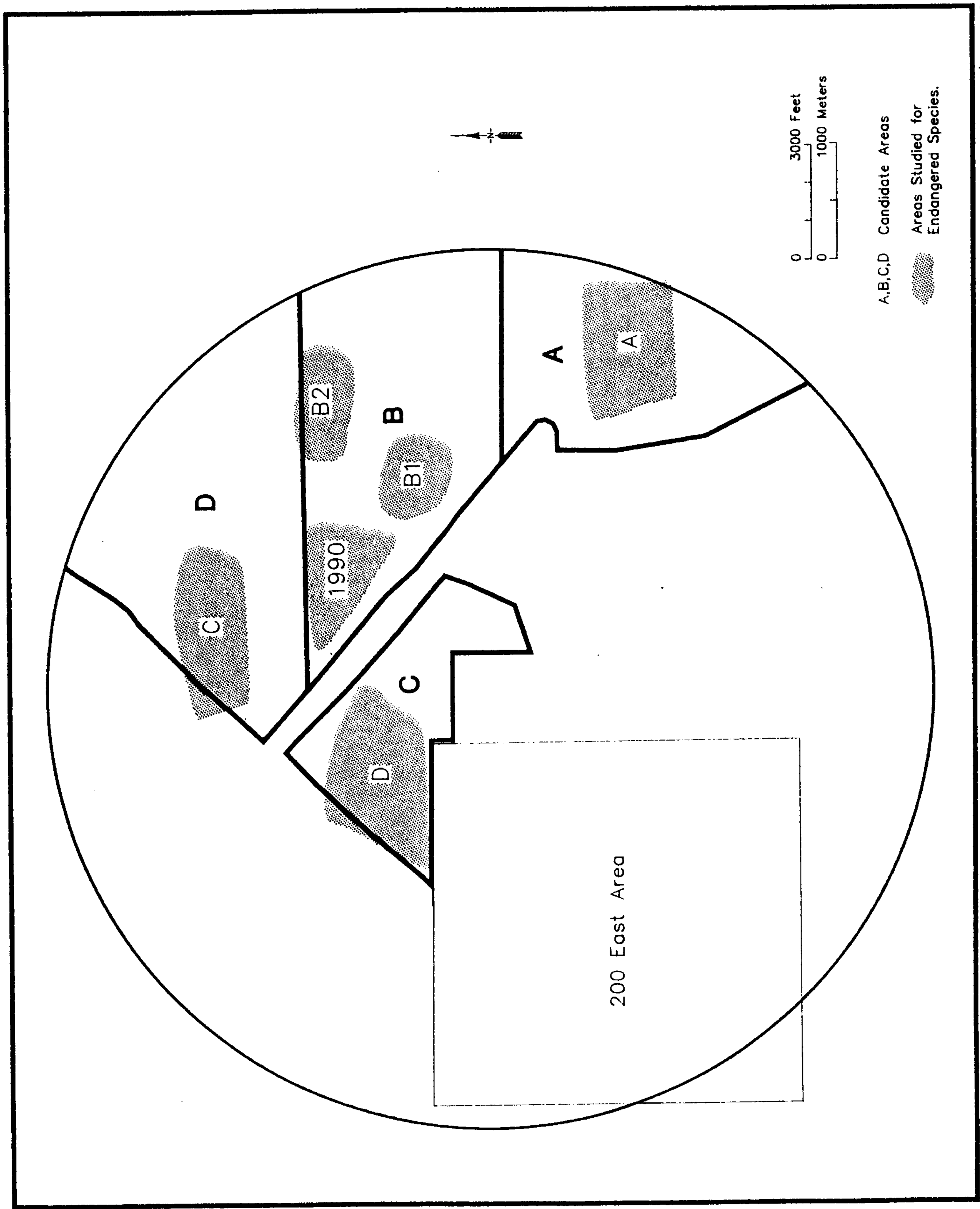

Figure C.1 Areas Within a 2-Mile Radius of the Liquid Effluent Retention Facility that Were Surveyed for Threatened, Endangered, or Sensitive Species.

Table C.2 Plant Species Found in Candidate Area "A".

AREA A - East of C-Lobe of B-Pond, T12N, R27E, Sec. 6. Stands of Mature Sagebrush interspersed with large, old burns and small blow-outs.
Date of Survey: 4/25/91

SPECIES	FAMILY	COMMON NAME
Artemesia tridentata	Asteraceae	Big sagebrush
Balsamorhiza careyana	Asteraceae	Carey's Balsamroot
Erigeron poliospermus	Asteraceae	Cushion Fleabane
Erigeron divergens	Asteraceae	Diffuse Fleabane
Chrysothamnus viscidiflorus	Asteraceae	Green Rabbitbrush
Chaenactis douglasii	Asteraceae	Hoary False yarrow
Tragopogon dubius	Asteraceae	Goatsbeard
Achillea millifolium	Asteraceae	Yarrow
Bromus tectorum	Poaceae	Cheatgrass
Poa sandbergii	Poaceae	Sandberg's Bluegrass
Sitanion hystrix	Poaceae	Squirreltail
Oryzopsis hymenoides	Poaceae	Indian Ricegrass
Koleria cristata	Poaceae	Prairie Junegrass
Zigadenus venenosus	Liliaceae	Death Camas
Fritillaria pudica	Liliaceae	Yellow bell
Brodiaea douglasii	Liliaceae	Douglas' Brodiaea
Sysimbrium altissimum	Brassicaceae	Jim hill Mustard
Descurainia pinnata	Brassicaceae	Tansymustard
Erysimum asperum	Brassicaceae	Wallflower
Astragalus caricinus	Fabaceae	Buckwheat Milkvetch
Astragalus sclerocarpus	Fabaceae	Stalkedpod Milkvetch
Delphinium nuttallianum	Ranunculaceae	Upland Larkspur
Mentzelia albicaulis	Loasaceae	Mentzelia
Comandra umbellata	Santalaceae	Bastard Toadflax
Oenothera pallida	Onagraceae	Pale Evening Primrose

Table C.2 - AREA A - Continued -

SPECIES	FAMILY	COMMON NAME
Amsinkia lycopsoides	Boraginaceae	Tarweed Fiddleneck
Amsinkia tessellata	Boraginaceae	Tessellate Fiddleneck
Cryptantha pterocarya	Boraginaceae	Winged Cryptanth
Cryptantha circumscissa	Boraginaceae	Matted Cryptanth
Penstemon speciosus	Scrophulariaceae	Royal Penstemon
Phacelia linearis	Hydrophyllaceae	Threadleaf Phacelia
Phlox longifolia	Polemoniaceae	Long-leaf Phlox
Microsteris gracilis	Polemoniaceae	Pink Gracilis
Gilia leptomeria	Polemoniaceae	Great Basin Gilia
Grayia spinosa	Chenopodiaceae	Hopsage
Salsola kali	Chenopodiaceae	Russian Thistle
Holosteum umbellatum	Caryophyllaceae	Jagged Chickweed
Cymopteris terebinthinus	Apiaceae	Terpentine Cymopteris

Additional species identified in follow-up searches June 3-4 1991:.

SPECIES	FAMILY	COMMON NAME
Erigeron piperianus *	Asteraceae	Piper's Daisy
Macheranthera canescens	Asteraceae	Hoary Aster
Ambrosia ancanthicarpa	Asteraceae	Bursage
Erigeron filifolius	Asteraceae	Thread-leaf Fleabane
Erigeron pumilus	Asteraceae	Shaggy Fleabane
Agropyron dasytachyum	Poaceae	ThickspikeWheatgrass
Orobanche corymbosa	Orobanchaceae	Flat-top Broomrape
Eriogonum vimineum	Polygonaceae	Broom Buckwheat
Salvia dorrii	Lamiaceae	Purple Sage
Calochortus macrocarpus	Liliaceae	Mariposa Lily

* Listed as "sensitive" by the Washington Natural Heritage Program

Table C.3 Plant Species Found in Candidate Area "B".

AREA B1 - NE of 200 East Area, North of Railroad tracks, T13N, R27E, Sec 31. Mature Sagebrush/Bluegrass in NW portion, Most of remaining area appears to have been burned within the last 10 - 20 years.

Date of Survey: 4/24/91

SPECIES	FAMILY	COMMON NAME
Artemesia tridentata	Asteraceae	Big Sagebrush
Achillea millifolium	Asteraceae	Yarrow
Chrysothamnus viscidiflorus	Asteraceae	Green Rabbitbrush
Balsamorhiza careyana	Asteraceae	Carey's Balsamroot
Erigeron poliospermus	Asteraceae	Cushion Fleabane
Erigeron pumilus	Asteraceae	Shaggy Fleabane
Tragopogon dubius	Asteraceae	Goatsbeard
Grayia spinosa	Chenopodiaceae	Hopsage
Salsola kali	Chenopodiaceae	Russian Thistle
Sysimbrium altissimum	Brassicaceae	Jim Hill Mustard
Poa sandbergii	Poaceae	Sandberg's Bluegrass
Koleria cristata	Poaceae	Prairie Junegrass
Bromus tectorum	Poaceae	Cheatgrass
Phlox longifolia	Polemoniaceae	Long-leaf Phlox
Microsteris gracilis	Polemoniaceae	Pink Gracilis
Holosteum umbellatum	Caryophyllaceae	Jagged Chickweed
Astragalus caricinus	Fabaceae	Buckwheat Milkvetch
Astragalus sclerocarpus	Fabaceae	Stalkedpos Milkvetch
Delphinium nuttalianum	Ranunculaceae	Upland Larkspur
Lappula redowskii	Boraginaceae	Western Stickseed
Cymopteris terebinthinus	Apiaceae	Terpentine cymopteris
Lomatium sp.	Apiaceae	Desert parsley
Rumex venosus	Polygonaceae	Winged Dock
Commandra umbellata	Sandalaceae	Bastard Toadflax

Table C.3 - Continued -

AREA B2. South side of Rt. 11A, T13N, R27E, Sec. 31. Relatively thin stand of mature sagebrush, strong cheatgrass understory, thinning out to tumble mustard / cheatgrass to south. Date of Survey: 16 May 1991

SPECIES	FAMILY	COMMON NAME
Artemisia tridentata	Asteraceae	Big Sagebrush
Tragopogon dubius	Asteraceae	Goatsbeard
Crepis atrabarbara	Asteraceae	Hawksbeard
Chaenactis douglasii	Asteraceae	Hoary False Yarrow
Erigeron poliospermus	Asteraceae	Cushion Fleabane
Erigeron filifolius	Asteraceae	Threadleaf Fleabane
Erigeron pumilus	Asteraceae	Shaggy Fleabane
Achillea millifolium	Asteraceae	Yarrow
Chysothamnus viscidiflorus	Asteraceae	Green Rabbitbrush
Balsamorhiza careyana	Asteraceae	Carey's Balsamroot
Layia glandulosa	Asteraceae	White-Daisy Tidytips
Poa sandbergii	Poaceae	Sandberg's Bluegrass
Bromus tectorum	Poaceae	Cheatgrass
Sitanion hystrix	Poaceae	Squirreltail
Stipa comata	Poaceae	Needle-and-thread
Agropyron dasytachyum	Poaceae	Thick-spike Wheatgrass
Cymopteris terebinthinus	Apiaceae	Terpentine Cymopteris
Lomatium canbyi	Apiaceae	Canby's Lomatium
Amsinkia tesselata	Boraginaceae	Tessellate Fiddleneck
Amsinkia lycopsoides	Boraginaceae	Tarweed Fiddleneck
Cryptantha circumscissa	Boraginaceae	Matted Cryptanth
Cryptantha ambigua	Boraginaceae	Obscure Cryptanth
Cryptantha pterocarya	Boraginaceae	Winged Cryptanth
Plectritis macrocera	Valerianaceae	White Plectritis
Mentzelia albicaulis	Loasaceae	Mentzelia

Table C.3 - AREA B2 - Continued.

SPECIES	FAMILY	COMMON NAME
Chenopodium leptophyllum	Chenopodiaceae	Slimleaf Goosefoot
Salsola kali	Chenopodiaceae	Russian Thistle
Grayia spinosa	Chenopodiaceae	Hopsage
Sysimbrium altissimum	Brassicaceae	Jim Hill Mustard
Descurainia pinnata	Brassicaceae	Tansymustard
Holosteum umbellatum	Caryophyllaceae	Jagged Chickweed
Phacelia linearis	Hydrophyllaceae	Threadleaf Phacelia
Astragalus caricinus	Fabaceae	Buckwheat Milkvetch
Lupinus pucillus	Fabaceae	Rusty Lupine
Calochortus macrocarpus	Liliaceae	Mariposa Lily
Brodiaea douglasii	Liliaceae	Douglas' Brodiaea
Phlox longifolia	Polemoniaceae	Long-leaf Phlox
Gilia leptomeria	Polemoniaceae	Great Basin gilia
Microsteris gracilis	Polemoniaceae	Pink Gracilis

Table C.4 Plant Species Found in Candidate Area "C".

AREA C - N of route 11A, E of Gable Pond, T13N, R26E sec 25. Mature sagebrush community with strong Poa understory, very mature and complete cryptogamic crust. Date of Survey: 04 June 1991

SPECIES	FAMILY	COMMON NAME
Artemesia tridentata	Asteraceae	Big Sagebrush
Achillea millifolium	Asteraceae	Yarrow
Crepis atrabarba	Asteraceae	Slender Hawksbeard
Macheranthera canescens	Asteraceae	Hoary Aster
Balsamorhiza careyana	Asteraceae	Carey's Balsamroot
Erigeron pumilus	Asteraceae	Shaggy Fleabane
Erigeron poliospermus	Asteraceae	Cushion Fleabane
Erigeron filifolius	Asteraceae	Threadleaf Fleabane
Tragopogon dubius	Asteraceae	Goatsbeard
Ambrosia acanthicarpa	Asteraceae	Bursage
Cheanactis douglasii	Asteraceae	Hoary False-Yarrow
Crysothamnus viscidiflorus	Asteraceae	Green Rabbitbrush
Bromus tectorum	Poaceae	Cheatgrass
Poa sandbergii	Poaceae	Sandberg's Bluegrass
Sitanion hystrix	Poaceae	Squirreltail
Oryzopsis hymenoides	Poaceae	Indian Ricegrass
Stipa commata	Poaceae	Needle-and-thread
Cymopteris terebinthinus	Apiaceae	Turpentine Cymopteris
Lomatium sp.	Apiaceae	Desert Parsley
Chenopodium leptophyllum	Chenopodiaceae	Slimleaf Goosefoot
Grayia spinosa	Chenopodiaceae	Spiny hopsage
Salsola kali	Chenopodiaceae	Tumbleweed
Phacelia linearis	Hydrophyllaceae	Threadleaf Phacelia
Nama densum	Hydrophyllaceae	Matted Nama
Astragalus caricinus	Fabaceae	Buckwheat Milkvetch
Astragalus sclerocarpus	Fabaceae	Stalkedpod Milkvetch

Table C.4 - AREA C - Continued:

SPECIES	FAMILY	COMMON NAME
Coldenia nuttallii	Boraginaceae	Nuttall's Coldenia
Cryptantha circumscissa	Boraginaceae	Matted Cryptanth
Gilia leptomeria	Polemoniaceae	Great Basin Gilia
Phlox longifolia	Polemoniaceae	Long-leaf Pholx
Microsteris gracilis	Polemoniaceae	Pink gracilis
Descurainia pinnata	Brassicaceae	Tansy Mustard
Sisymbrium altissimum	Brassicaceae	Jim Hill Mustard
Eriogonum vimineum	Polygonaceae	Broom Buckwheat
Calochortus macrocarpus	Liliaceae	Mariposa Lily
Zigadenus sp.	Liliaceae	Death Camas
Stellaria longipes	Caryophyllaceae	Longstalk starwort
Commandra umbellata	Sandaleaceae	Bastard Toadflax
Orobanche corymbosa	Orobanchaceae	Flattop Broomrape
Mentzelia albicaulis	Loasaceae	Mentzelia

Table C.5 Plant Species Found in Candidate Area "D".

AREA D - NE of 200 East Area, along road to NE gate, T13N, R26E Sec. 35 & 36. Mature Shrubs, strong Poa understory, small patches of open sand. Date of Survey: 3 May 91.

SPECIES	FAMILY	COMMON NAME
Artemesia tridentata	Asteraceae	Big Sagebrush
Balsamorhiza careyana	Asteraceae	Carey's Balsamroot
Erigeron poliospermus	Asteraceae	Cushion Fleabane
Erigeron pumilus	Asteraceae	Shaggy Fleabane
Erigeron filifolius	Asteraceae	Threadleaf Fleabane
Tragopogon dubius	Asteraceae	Goatsbeard
Achillea millifolium	Asteraceae	Yarrow
Chaenactis douglasii	Asteraceae	Hoary False Yarrow
Chrysothamnus viscidiflorus	Asteraceae	Green Rabbitbrush
Chrysothamnus nauseosus	Asteraceae	Grey Rabbitbrush
Layia glandulosa	Asteraceae	White-Daisy Tidytips
Crepis atrabarbara	Asteraceae	Hawksbeard
Grayia spinosa	Chenopodiaceae	Hopsage
Salsola kali	Chenopodiaceae	Russian Thistle
Poa sandbergii	Poaceae	Sandberg's Bluegrass
Bromus tectorum	Poaceae	Cheatgrass
Oryzopsis hymenoides	Poaceae	Indian Ricegrass
Sitanion hystrix	Poaceae	Squirreltail
Koleria cristata	Poaceae	Prairie Junegrass
Agropyron dasytachyum	Poaceae	Thick-spike Wheatgrass
Festuca octoflora	Poaceae	Six-weeks Fescue
Stipa comata	Poaceae	Needle-and-thread
Eriogonum ovalifolium	Polygoniaceae	Cushion Buckwheat
Commandra umbellata	Sandalaceae	Bastard Toadflax
Penstemon speciosa	Scrophulariaceae	Royal Penstemon

Table C.5 - AREA D - Continued.

SPECIES	FAMILY	COMMON NAME
Lupinus pucillus	Fabaceae	Rusty Lupine
Astragalus caricinus	Fabaceae	Buckwheat Milkvetch
Astragalus sclerocarpus	Fabaceae	Stalkedpod Milkvetch
Astragalus succumbens	Fabaceae	Crouching Milkvetch
Phlox longifolia	Polemoniaceae	Long-leaf Phlox
Gilia leptomeria	Polemoniaceae	Great Basin Gilia
Microsteris gracilis	Polemoniaceae	Pink Gracilis
Amsinkia lycopsoides	Boraginaceae	Tarweed Fiddleneck
Amsinkia tessellata	Boraginaceae	Tessellate Fiddleneck
Cryptantha circumscissa	Boraginaceae	Matted Cryptanth
Cryptantha pterocarya	Boraginaceae	Winged Cryptanth
Phacelia linearis	Hydrophyllaceae	Threadleaf Phacelia
Delphinium nuttallianum	Ranunculaceae	Upland Larkspur
Lomatium sp.	Apiaceae	Desert Parsley
Cymopteris terebinthinus	Apiaceae	Terpentine Cymopteris
Sysimbrium altissimum	Brassicaceae	Jim Hill Mustard
Descurainia pinnata	Brassicaceae	Tansy Mustard
Brodiaea douglasii	Liliaceae	Douglas' Brodiaea
Mentzelia albicaulis	Loasaceae	Mentzelia
Plantago patagonica	Plantaginaceae	Indian Wheat

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